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Report 1906/07

DEPARTMENT OF COMMERCE AND LABOR
BUREAU OF FISHERIES
GEORGE M. BOWERS, Commissioner

THE FISHES OF THE CONNECTICUT LAKES AND NEIGHBORING WATERS

WITH NOTES ON THE

PLANKTON ENVIRONMENT

Bureau of Fisheries Document No. 633

WASHINGTON
GOVERNMENT PRINTING OFFICE
1908

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THE FISHES OF THE CONNECTICUT LAKES AND NEIGHBORING WATERS, WITH NOTES ON THE PLANKTON ENVIRONMENT

By W. C. KENDALL and E. L. GOLDSBOROUGH

Bureau of Fisheries Document No. 633

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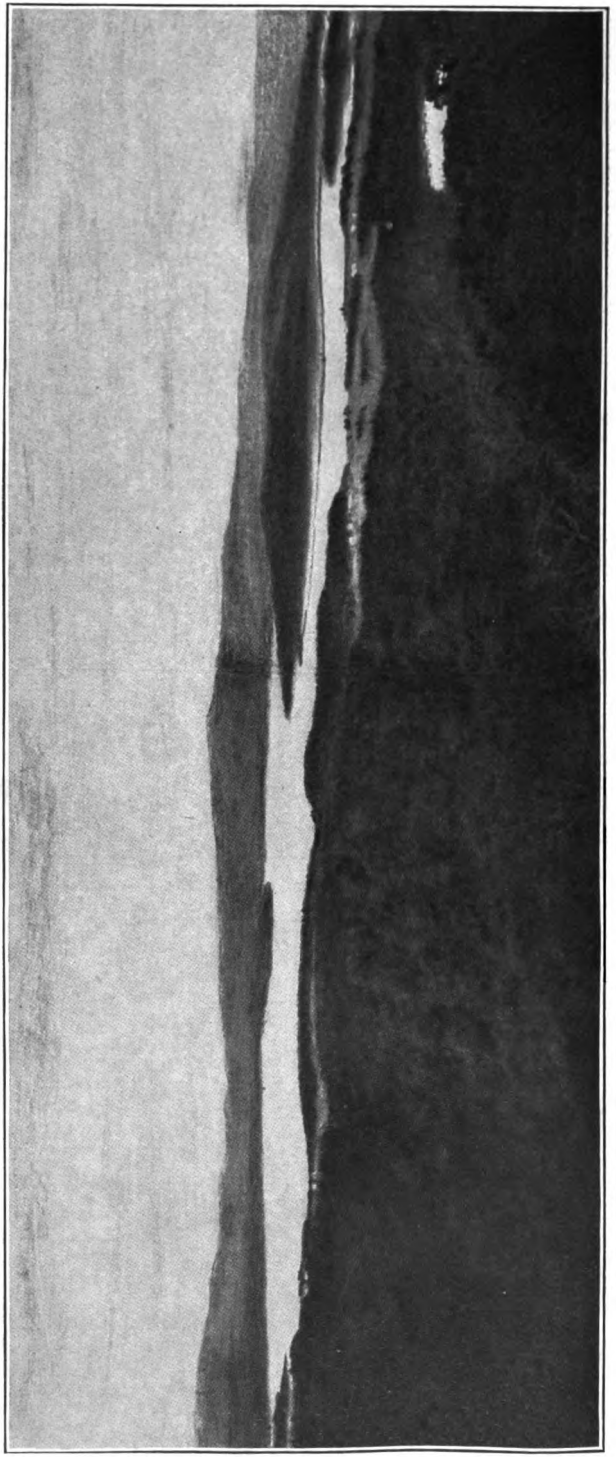

FIRST CONNECTICUT LAKE, LOOKING SOUTHEASTWARD.

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THE FISHES OF THE CONNECTICUT LAKES AND NEIGHBORING WATERS, WITH NOTES ON THE PLANKTON ENVIRONMENT.

By W. C. KENDALL and E. L. GOLDSBOROUGH.

INTRODUCTION.

For a number of years the United States Fish Commission conducted biological and physical investigations of the inland waters of Maine; and appreciating the great importance of such work in conjunction with fish-cultural operations, the Bureau of Fisheries decided to continue it in other New England states. The Connecticut Lakes were selected for the next work[a] for several reasons. Their proximity to the Vermont, Maine, and Canadian borders gives them particular interest in their bearings on the geographic distribution of fishes; they are the largest lakes north of the White Mountains in New Hampshire; they have received some fish-cultural attention; and they are the source of the Connecticut River, the largest river in New England. The lateness of the season at which the investigations were taken up and the short time spent in the region detract somewhat from the results. Most spring and summer breeding fishes had nearly spawned when observations were commenced, and the work was brought to a close before fall spawning had begun. Therefore much desired knowledge on these points was not acquired.

The geographic distribution of the fishes of this region, however, was very well made out, also their relative abundance. The feeding habits of some of the species were closely observed and the relations of the fishes to their surrounding conditions were noted so far

[a] The authors and Mr. A. A. Doolittle, of the Central High School, Washington, D. C., constituted the investigating party. Doctor Kendall and Mr. Goldsborough gave their attention chiefly to the fishes and a general study of the local conditions. Mr. Doolittle studied the plankton environment and the macroscopic invertebrates and flora. His report is published herewith, appended to the present article.

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as possible. Accordingly in these pages the discussion of these subjects is taken up under two headings—that is, geographic distribution and the fishes. The first is treated under two subdivisions—(1) natural distribution, dealing with the indigenous species, and (2) artificial distribution, the fish-cultural dissemination.

Necessarily incidental to the study of the relations of fishes to their environment is a knowledge of the geographic and physical features of the locality. These subjects being less specifically our field, however, we give only a general description of the waters examined and such conclusions as we are able to draw from our work.

Attempt is made to present the report in a form which will be of popular interest and practical use, and the fishes therefore are treated as untechnically as is consistent with exactness and conciseness. But since most residents in this region and all visiting anglers are greatly interested in the local fishes and fishing, and among them there exists more or less confusion regarding the identity of some of the indigenous and probably all the introduced species, it has been the effort to present the results of the study of the fishes in such manner as will enable anyone to identify all that he finds. To that end a simple artificial key is presented, with instructions regarding its use. The species are arranged in the order adopted by Jordan and Evermann in their Fishes of North and Middle America. Each species is then taken up in the following manner: The common name, followed by the technical name and original authority for it; then a brief structural and color description, taken when possible from specimens collected in the region under discussion. The most common local names are then given, followed by the recorded general range of the species and local distribution as indicated by our collections. This is followed by a description of the habits of the species and other interesting or important facts mainly drawn from our own observations; after this, uses and best methods of capture, in accordance with our experience in these waters in particular and in other places in general.

Photographs taken by ourselves in this region are used to illustrate this report, together with drawings and photographs of the introduced species and some of the native game and food fishes.

LOCAL GEOGRAPHY AND PHYSICAL FEATURES.

The Connecticut Lakes, three in number, situated in the northern part of Coos County, N. H., near the Canadian and Maine borders, having an average elevation of 1,850 feet, are the principal and practically the ultimate source of the Connecticut River. The surrounding country consists of low mountains with accompanying valleys and bogs characteristic of northern New England. Much of

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the country from the north side of First Connecticut Lake down to the Vermont line has long been cleared and affords good farms, especially in the bottom lands of the river and its prinicpal tributaries. The remainder of the region is a vast forest extending north beyond the Canadian border, east far into Maine, and southward for many miles. The principal trees are spruce, fir, birches, and maples.

Lumbering operations formerly carried on here have been abandoned. But the dams and abutments that were built and the old log jams remain and have had a marked effect upon the conditions of the lakes and streams, and consequently upon their fauna and flora.

Regarding these lakes the state commissioners about ten years ago reported as follows:[a]

> The most northerly lakes in our State are the Connecticut Lakes. Within the last ten years they have become a famous resort for both the hunter and fisherman, the forests around them abounding in large game and their waters with both lake and speckled trout. Until quite recently it has not been deemed necessary to introduce into these waters any of the fry from our hatcheries, except some landlocked salmon, which were planted there by the commission in the days of the accomplished and genial Col. Sam Webber; and we are happy to state that within the last two years these lordly fish (which we believe will eventually become the most popular fish in the State) have come forward in considerable numbers and borne testimony to the wisdom and foresight of the aforesaid Colonel Webber. The late Colonel Hodge also planted 25,000 salmon in the tributaries of the First Connecticut Lake in the spring of 1892. The present commission, in view of the drain which is being made upon these waters by the numerous fishermen resorting thereto, are planting them with lake trout fry, of the New Found Lake variety, in large quantities; and it is our intention when we make our next distribution of fry to place in these waters, in addition to their quota of lake trout, a fair supply of brook trout and landlocked salmon, together with a quantity of fresh-water smelt as a food supply.

The principal waters of this region that came within the scope of our investigations, besides the three Connecticut Lakes, were their connecting and tributary streams and ponds and Indian and Perry streams. A brief general description of each follows.

Indian Stream.—This stream, which joins the Connecticut River about 13 miles below First Lake, has a very ramified source in the northern part of the state, its ultimate headwaters being on the Canadian boundary. Many of its uppermost branches are exceedingly close to streams flowing into the St. Francis River, which joins the St. Lawrence in "Lake St. Peter." Its course lies almost parallel

[a] Report of the Fish and Game Commission of New Hampshire to the Governor and Council, December, 1894.

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with that of Halls Stream[a] and Perry Stream. Many of its eastern branches are intimately close to western tributaries of Perry Stream. One of the largest of these branches is "East Branch," which is a famous trout stream. Lying just west of Back Pond is a chain of three small ponds, the largest of which is less than one-half mile in diameter, which discharge their waters through one of the lower eastern branches into Indian Stream 7½ or 8 miles above its junction with the river. Two of the ponds are named Moose Pond and Bower Pond, respectively, the latter being the largest of the three.

Indian Stream was examined from a point about 3 miles above the bridge over the main road down to the bridge. The bed of the stream is essentially gravelly; it is mostly shallow, with considerable descent and rapidity. In the distance of about a half mile or so above the bridge there were several deep holes having sandy and muddy bottoms. There were but few water plants. The stream averaged, perhaps, 30 feet in width at the time of our visit (August 4). The water was low and the bed to a great extent dry. In the spring there is sufficient water for log driving. In a field about a mile above the bridge there are a number of pools which are the remains of an overflow or "cut-off" at present not connected with the stream, but doubtless fed by springs. In these pools the following fishes were caught, some of them not obtained elsewhere in the region: Red-bellied minnow (*Chrosomus erythrogaster*), bronze minnow (*Leuciscus neogæus*), mud or brook chub (*Semotilus atromaculatus*), common chub (*S. bullaris*), longnose dace (*Rhinichthys cataractæ*), blacknose dace (*R. atronasus*), redfin (*Notropis cornutus*), young cusk or burbot (*Lota maculosa*), besides innumerable tadpoles and frogs (*Rana clamata* and *R. septentrionalis*). In the stream itself were taken chub, brook chub, longnose dace, longnose sucker (*Catostomus catostomus*), common sucker (*C. commersonii*), chub-minnow (*Couesius plumbeus*), and several blobs (*Cottus gracilis*). The temperature of the air was 70° and of the water 62° F.

Back Pond.—This pond is about 1⅛ miles long, with an extreme width of something over one-half mile. It is situated about 2½ miles above the junction of its outlet with the Connecticut River near Pittsburg. The main road to Connecticut Lakes, however, passes within sight of it. This pond was not visited, but it was learned from reliable sources that pickerel (*Esox reticulatus*) occur there as an introduced species, and trout are found in the outlet. It is said that Back Pond was once a good trout pond.

Perry Stream.—This stream has its source near the boundary line of northern New Hampshire and Canada in several small branches

[a] Halls Stream, forming a part of the boundary between New Hampshire and Canada, joins the Connecticut River near Beecher Falls, Vermont.

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and three or four very small ponds, one of which is named Wrights Pond. Throughout its course it has many small tributary branches, one of which takes its rise in a small pond to the westward. Perry Stream joins the Connecticut River about 2 miles below First Connecticut Lake. It was examined from a point about 5 miles above its mouth to its junction with the river. Between 1½ and 2 miles above the mouth of the stream there are several old dams. The section of the stream examined was less rapid in the upper 3 miles than below. Within this upper distance the bottom is sandy, but there are occasional riffles. There are numerous good trout pools, but evidently only a few trout. For the next mile or so down, the stream increases in size and the bottom consists of coarse angular fragments of the bed rock rather than bowlders. At the lower end there is about a mile of dead water occasionally interrupted by short riffles. There seemed to be but little aquatic vegetation; some algæ and pond weed were observed. The water of this stream is colder than that of Indian Stream. A few springs were observed to empty into it. The temperature of water of the stream on August 6 was 44° F., and of one of the springs 42°; the air was 76°.

The fishes obtained and observed were trout (*Salvelinus fontinalis*), longnose sucker (*C. catostomus*), and a few blobs (*Cottus gracilis*).

First Lake.—First Lake is the lowermost and largest of the chain, lying about latitude 45° 6′ north, longitude 71° 16′ west, at an elevation of 1,619 feet. It is very irregular in shape and approximately 4 miles long and 3 in extreme width. The long axis of the lake extends about east and west, but at its lower end curves to the south. The widest part of the lake is from the north shore to the south end of a deep cove known as South Bay. Stony Point marks the entrance to the bay on the east. Northeastward from this point, on the north shore of the lake, is Abbott Point, and correspondingly northwestward is Metallak Point. The distance from Stony Point to Abbott Point is a little over 1⅜ miles and just about 1⅜ miles from Stony Point to Metallak Point. A line joining the last two points marks the western limit of that portion of the lake which may be appropriately designated as East Bay, while a line extended to the opposite shore directly south from Metallak Point determines the eastern limit of the western section of the lake, which, for convenience, may be called West Bay.

With the exception of Main Inlet, the affluents of the lake are all small. On the south side there are some spring rivulets originating in the hills, of which Alder Brook, entering the lake on the southeast side of East Bay, is the largest. Main Inlet debouches into the lake on the northeast side of East Bay just east of Abbott Point. On the north side of the lake the most conspicuous tributaries are Mud

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Pond Brook, the outlet of Mud Pond, and Round Pond Brook, outlet of Round Pond. The first joins the lake just east of Metallak Point and the other about halfway between Metallak Point and the mouth of Main Inlet.

The shores of the lake vary in character, on the south side being mainly rocky and somewhat bolder than on the north side. Immediately south of Main Inlet the shore is swampy. The rest of the east shore of East Bay around to Stony Point is variously sandy and rocky, but mostly sandy north of the mouth of Alder Brook. Close to Stony Point are two small islands and some submerged ledges and bowlders.

South Bay on the east and south side is mostly rocky; on the west side there are beaches composed of rocks, small bowlders, sand, and mud, through which cold spring water trickles into the lake in a number of places. It was here that some large fish were seen rising. The rest of the south shore of the lake is mainly rocky to the outlet. The north shore from Abbott Point to Metallak Point consists for the most part of a sand beach with occasional short stretches of rocks. At the mouths of the brooks it is somewhat swampy. From Metallak Point west for about three-fourths of a mile the shore is composed to a great extent of loose rocks and projecting jagged ledges in situ. This is followed by a swampy area, and on the northwest side a shallow cove is full of old stumps, logs, and dead trees, known in backwoods parlance as "dry kye."

The only muddy bottoms near shore are at the western end of the lake, the estuary-like entrance of Main Inlet, and the mouth of Mud Pond Brook. The northern and eastern shores present gravel and sand, respectively, and South Bay a stony offshore bottom, with a slight mud filling between the bowlders. Throughout the lake at large the character of the bottom is a very easily disturbed granular black dirt, into which the sounding lead sank 8 or 10 inches and reached a substratum of yellow slimy mud.

The history of the lake shows that the level of the water has been 2 to 3 feet higher than the level of the season of 1904. It was higher during the season of 1903. There is abundant evidence of former higher level of water on the shores, viz, the higher former shore line, almost bare beaches of sand and gravel; the dead standing trees whose roots have been covered by water during long periods; and the testimony of residents and visitors who find that the marshes and shallow feeding grounds of water and shore birds have largely disappeared. The present area of marshy ground contiguous to the lake is probably less than an acre. The level of the lake is now possibly near the level before the dam was built across the outlet.

The bottom of the lake at large gradually slopes from the shore to a depth of 70 feet, which is maintained over most of its area. The

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nearer the point of entrance of Main Inlet, the more gradual the slope, due to the deposit of silt in freshet time. The depth in the immediate vicinity of the entrance is 4 to 6 feet, and a large part of this region ranges from 40 to 50 feet in depth. Around the shores of this lake there was no shallow littoral bench or shelf such as existed in the other lakes and ponds visited, but a fairly uniform descent to the deeper waters.

The offshore body of water is generally pretty deep. The deepest place found by numerous soundings was 140 feet, about three-fourths of a mile southeastward from Metallak Point and less than one-fourth mile northeastward of Greens Point, which is a little east of south of Metallak Point, near the entrance to South Bay. About halfway from Abbott Point to Stony Point there is a depth of 70 feet, toward the latter point shoaling to 50, then increasing to 70 feet again about one-fourth of a mile off the point. Off Abbott Point it rapidly deepens to 35 feet, and about halfway between this point and Metallak Point there is a depth of 70 feet.

South Bay has deep water over most of its area and generally close to shore. The greatest depth is 130 feet, almost midway between the shores and directly west of Stony Point, and 120 feet is found farther down the bay, and 100 feet over half a mile from the entrance. The greater depths are found nearer the west than the east shore. The depth of West Bay decreases from about 88 feet off Metallak Point to 79 or 80 feet about three-fourths of a mile farther west, thence rapidly shoals to the outlet.[a]

The fishes found near the lake in the small affluents are considered here as a part of the lake fauna. The following is a list of the species collected by us in these places and in the lake:

Longnose sucker (*Catostomus catostomus*).
Common sucker (*Catostomus commersonii*).
Chub (*Semotilus bullaris*).
Redfin (*Notropis cornutus*).
Longnose dace (*Rhinichthys cataractæ*).
Blacknose dace (*Rhinichthys atronasus*).
Chub-minnow (*Couesius plumbeus*).
Eel (*Anguilla chrisypa*).
Brown trout (*Salmo fario*).
Trout (*Salvelinus fontinalis*).
Blob (*Cottus gracilis*).
Burbot (*Lota maculosa*).

Of these, chubs and chub-minnows appeared to be the most abundant; small blobs were common; cusk and eels doubtless numerous enough; suckers of two kinds plentiful; redfins not numerous, and neither of the two kinds of dace very abundant. It could not be de-

[a] The temperature records of this lake and the other waters examined are given in Mr. Doolittle's section of this report.

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termined whether a reputed scarcity of game fishes was real or only apparent. If real, it is impossible to say just what conditions are responsible for it.

There is plenty of deep cool water, and in the small fishes an abundant food supply. During the stay here, however, there was a remarkable scarcity of insects, which might be due to either of two causes, the cold season, which perhaps is not always present, or the fresh westerly winds that blew nearly every day almost with the regularity of trade winds. Calms were very infrequent. Nearly every evening after sunset in pleasant weather there was a light easterly breeze, which continued until morning. Even if the morning was calm, before noon the cool westerly wind would spring up.

Mud Pond and Brook.—Mud Pond is hardly worthy of notice except that it is the source of Mud Pond Brook, and that, notwithstanding its peculiarly unfavorable character, it contains trout.

The pond is not over 5 or 6 acres in extent and is surrounded by boggy shores in which cranberries, callas, potentilla, pitcherplant, and sweet gale and other shrubs grow. The bottom of the pond consists of oozelike mud, the depth of which could not be found with a 4-foot oar. The water at the time of our visit, July 21, was not much over 1 foot deep. The yellow water lily abounds and there is some pond weed. In places the stout roots of the pond lily were exposed in masses almost sufficient to bear one's weight. It is said that trout are caught in this pond in the spring. We caught mud chub and chub-minnows. In a small spring brook there were many trout from 3 to 7 or 8 inches long. They were very shy, and after a few had been caught no more would bite. The temperature in this brook, which had its source in a nearby springy or boggy place, was 52° F.; at its mouth it was 54° F.; in the pond it was 72° F.

The outlet near the pond was shallow, and even dry in places, or the water ran underground. It was so overgrown with bushes that it could not be explored far from the pond. Where the main road crosses it, about half a mile from First Lake, it is a narrow brook but 2 or 3 feet wide, with here and there comparatively deep pools. In the brook are many small trout (*Salvelinus fontinalis*) up to 8 or 9 inches long, and brown trout (*Salmo fario*) up to 9 inches long. The latter are chiefly in the lower half mile of the brook.

Most of the chub-minnows, suckers, and blobs caught in this brook were found near First Lake.

Round Pond.—It is probably 3 or 4 miles by the connecting brook from Round Pond to First Lake. The pond has an area of about 20 acres, being about one-fifth of a mile in diameter and approximately round, or about as round as "round ponds" usually are. It is nearly surrounded by hills, high enough, perhaps, to be designated by the name of mountains.

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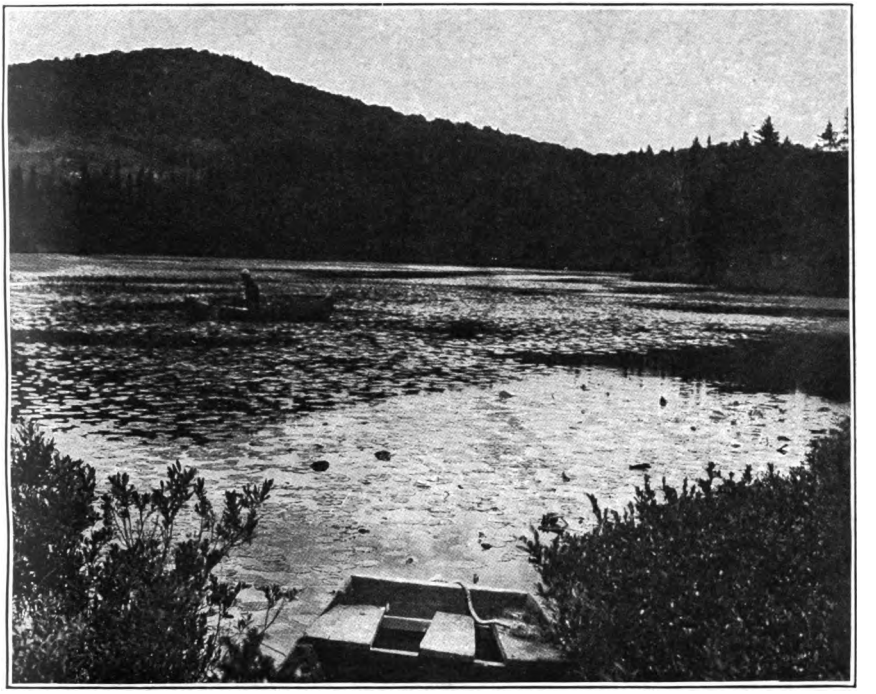

MUD POND.

SHORE OF MAIN INLET.

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Numerous soundings revealed a maximum depth of about 47 feet. From the middle to the east side there is considerable deep water. Toward the outlet, west shore and north shore, the water shoals, excepting that it deepens somewhat abruptly off the northeast point.

The outlet cove contains a considerable growth of pond weed, and the bottom in shallow water all around the pond bears a profuse growth of pipewort. In the northwest portion there is shallow water and muddy bottom, with a rather luxuriant growth of yellow pond lily. In deep water in many places, even in the middle of the pond, the bottom seems to be covered with a dense growth of fine, green algæ. The pond has no inlets, save some tiny rivulets from near-by spring ground, and it is doubtless fed by subaqueous springs.

The water is cold and, so far as we are able to judge, is well suited to trout, of which, according to popular report, there are many in the pond. Besides trout, there are also numerous chub-minnows, and many water newts (*Diemyctylus viridescens*), which were seen feeding at the surface of the water, swimming up from the bottom, taking insects, and immediately returning to the bottom. They made little wakes at the surface that were at first thought to be caused by some small fish.

Trout are said to be caught near shore when biting well, especially at the south and north ends of the pond. The few caught by us, however, were taken near the middle of the lake in about 25 feet of water.

Main Inlet of First Lake.—This stream is the outflow of Second Lake. It is about 4½ miles in length and for a good part of its course is swift and rocky, but there are some dead waters and deep pools. It has a descent of about 200 feet between First and Second lakes. There are two good-sized tributary streams, Coon Brook and Big Brook, which are now, or were once, good trout streams. Coon Brook is formed by the union of two small branches some 3 or 4 miles, perhaps, from Main Inlet. It is a clear, cool, rocky brook, much overgrown with alders and other bushes, and in many places full of old snags and fallen dead trees.

Big Brook has its source in Unknown Pond and flows southward as a clear, cool, rocky stream to join Main Inlet about 2 miles below Second Lake. It is overgrown with bushes and in places full of old logs like other woods brooks of this region.

Main Inlet affords numerous excellent spawning grounds for the various members of the salmon family. The lower mile or so is still water, with sand and mud bottom and abounding with aquatic plants.

The shores of this dead water are low and muddy or sandy, covered with shore grasses and old stumps. The fishes of the inlet at the season of our visit consisted mainly of suckers, chubs, chub-minnows, and blacknose dace. The dace were most common in quick water; the other species in quiet places, like pools and eddies. Most chubs and suckers were found in the dead water at the lower end of the inlet,

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although they were not uncommon in every dead-water pool. Trout when present were always at the mouths of spring inlets, as Coon and Big brooks.

Unknown Pond.—This pond is a tributary of Main Inlet of First Lake through Big Brook. It was not visited in this work, but is said to be an old beaver pond. Descriptions of it given by those who have been there indicate that it has an area of but a few acres and is shallow, but the water is clear and cool. This pond contains trout, some of which are of pretty good size. Some seen by us weighed over 2 pounds each.

Second Lake.—The long axis of Second Lake, lying about north and south, is about 2⅜ miles long. It varies in width from a half to 1⅜ miles. The principal affluents are West, Main, Middle, and East inlets, of which Main and East inlets are the largest. The littoral bottom and immediate shores vary considerably in character. Across the head of the lake the water is shallow, the bottom sandy and muddy, and there is an abundant growth of aquatic plants. About the mouths of the inlets the shore is low, producing a growth of shrubs, bluejoint and other grasses. On the eastern shore of the north end of the lake is Hinman Point, a rocky cape forming the southern limit of a large cove. Within this cove there are swampy shores and muddy or sandy bottom. South of Hinman Point much of the shore is a sandy beach interrupted by occasional rocky or swampy places. On this side of the lake the water is shallow for some distance into the lake, the bottom is mostly sand or mud, and there are patches of aquatic plants, especially off the mouths of inflowing streams. At the south and southwest end of the lake, especially in the neighborhood of the outlet, the shores are boggy and swampy, the water is not very deep, about 10 to 20 feet in the deeper portions, the bottom consists of sand and mud, and there is a profuse growth of water plants.

On the west side a point marking the northern limit of the area just mentioned is rocky, and this character obtains for the most part to the north end of the lake. Fairly deep water more closely approaches the shore here than on the east side. Near the north end there is a rocky shoal or reef reaching some distance into the lake.

This lake was found to be shallower in proportion to its size than the neighboring lakes or ponds. A maximum depth of 65 feet was found a short distance off the hill on the southwest shore of the main part of the lake. A channel ran from the head of West Cove, where Main Inlet enters, through this point to the strait leading into South Bay. On the western side of the channel the depth was maintained fairly well to about 150 feet from the shore. Here the depth diminished rapidly to 4 feet at about 30 feet from shore, forming a distinct limnetic bench. On the east side of the channel the bottom was at a general depth of 30 feet, except East Cove, which measured 15 feet deep. South Bay showed a general depth of 10 to 15 feet. The bottom throughout the lake was a deep, flow mud.

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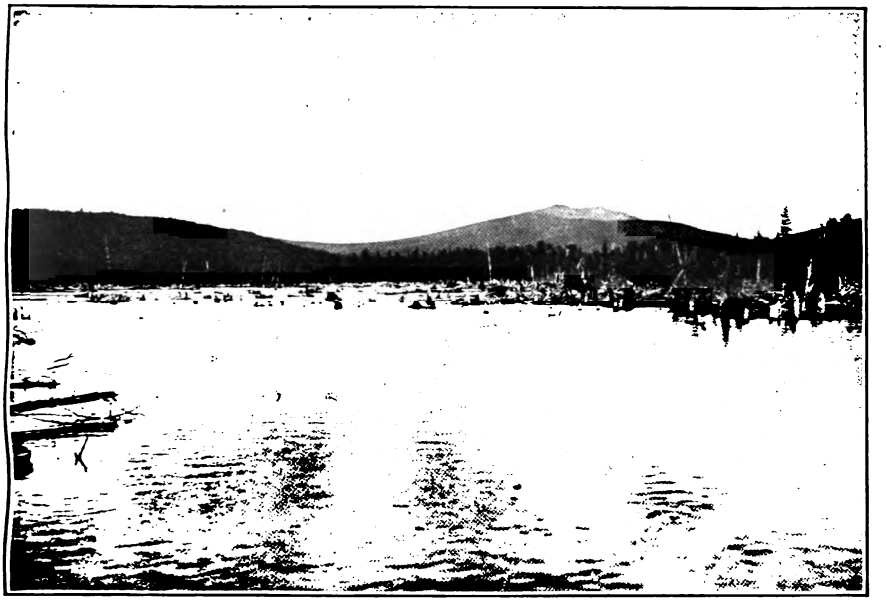

EAST INLET OF SECOND LAKE.

EAST INLET OF SECOND LAKE NEAR UPPER END OF DEADWATER.

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East Inlet.—Next to Main Inlet this stream is the largest entering Second Lake. The lower 3 miles is mostly swift, rocky, and turbulent. About 3 miles from the lake there is a dam, which has backed the water up 5 or 6 miles, practically making a pond and dead water full of old stumps and dead trees, especially in the lower part. The upper course of the inlet is a characteristic rough and rocky mountain brook. This inlet has been a remarkable trout stream. It is probably fished more than any other stream in the vicinity and hundreds of trout are taken from it every year. Most of the fish are small, however, seldom being over a half-pound in weight.

Other fish observed in the inlet above the dam were chub-minnow and redfin. Below the dam near the mouth of the stream were secured, besides the above-mentioned species, longnose dace and young cusk or burbot.

Main Inlet of Second Lake.—Main Inlet is the outlet of Third Lake. Over most of its course it is a swift, gravelly, and rocky stream. About 1 mile or more of its lower end is dead water, navigable by boats. There are two other dead-water tracts in its course, the lower being about 3 miles from Second Lake. About 2 miles from the lake the inlet is joined by a considerable stream, said to come from Scotts Bog, where excellent trout fishing is found. Main Inlet would be an excellent spawning ground for trout, salmon, and whitefish, although it is more or less obstructed by an old log jam, perhaps 2 miles from Second Lake.

Trout probably resort to this stream to spawn, though it is not now considered a very good trout stream. In the past, however, many were caught there, and the midway dead water was once a favorite spot. At present a good many fine trout are taken in the lower dead water, especially near the mouth of the stream. These fish, however, have doubtless run in from the lake. In August good trout fishing was found just within the mouth of the inlet. In September just outside among the water plants trout and "lakers" were caught. The only other species observed in Main Inlet, excepting just below Third Lake, were chub-minnows.

The fishes collected in Second Lake and inlets are as follows:

Longnose sucker (*Catostomus catostomus*).
Common sucker (*Catostomus commersonii*).
Redfin (*Notropis cornutus*).
Longnose dace (*Rhinichthys cataractæ*).
Blacknose dace (*Rhinichthys atronasus*).
Chub-minnow (*Couesius plumbeus*).
Eel (*Anguilla chrisypa*).
Laker (*Cristivomer namaycush*).
Trout (*Salvelinus fontinalis*).
Blob (*Cottus gracilis*).
Burbot or cusk (*Lota maculosa*).

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Third Lake.—This lake was estimated to be about three-fourths of a mile in its longest diameter, which extends about north and south, and about one-fourth mile east and west directly across the middle. There are no large inlets, but several spring brooks enter it at various points. In times of high water these brooks are doubtless much larger, but at the time of this visit they were practically dry in many places or, in some instances, trickling underground. The principal affluent is Main Inlet, entering the southwest corner. The immediate surrounding country is more abruptly hilly or mountainous than that of either of the other lakes.

The lake is very uniformly deep, there being but a narrow shelf of really shallow water except in some small coves like those of Main Inlet and the outlet. In these places there is some aquatic vegetation; off Main Inlet there is a considerable growth of pondweed. Inside of this the bottom on the sandy shelf supports a profuse growth of pipewort. The maximum depth found was 103 feet, and there seemed to be a very general depth of 80 to 100 feet.

The fishes observed in Third Lake and outlet just below the lake were: Sucker (*C. commersonii*), mud chub, longnose dace, blacknose dace, chub-minnow, and trout. It is said that cusk and eels occur in the lake.

Fourth Lake.—Many have heard of, but few have seen, Fourth Connecticut Lake. Some, claiming to know, maintain that it is at the head of a small brook entering the northwest corner of Third Lake. Others who have seen it affirm that the lake is nothing but a "mud puddle" at the head of Third Lake Main Inlet. Some maps show one good-sized pond at the head of one or the other of these brooks; others represent two ponds, one at the head of each. In order to ascertain the facts, both brooks were explored to their very heads. Main Inlet a short distance from Third Lake is formed by three branches, two of which proceed from spring or swamp ground, the other, the largest and more brook like, from higher ground. Perhaps 2 miles westward of Third Lake the latter brooklet rises in a shallow mud pond, 75 or 80 feet in diameter, and full of aquatic plants. The water is cold, originating in springs. No fishes were found there.

The brook entering the northwest corner of Third Lake was followed until no stream remained to be traced. At perhaps a mile from the lake three small rivulets, swelled by springs, unite to form the brook. Each one of these branches was followed to its last drop of water, but no pond was found.

It is probable that the pool at the head of Main Inlet is the only "Fourth Lake." The inlets of Third Lake are all so small a short distance from the lake that any one of them can be stepped across

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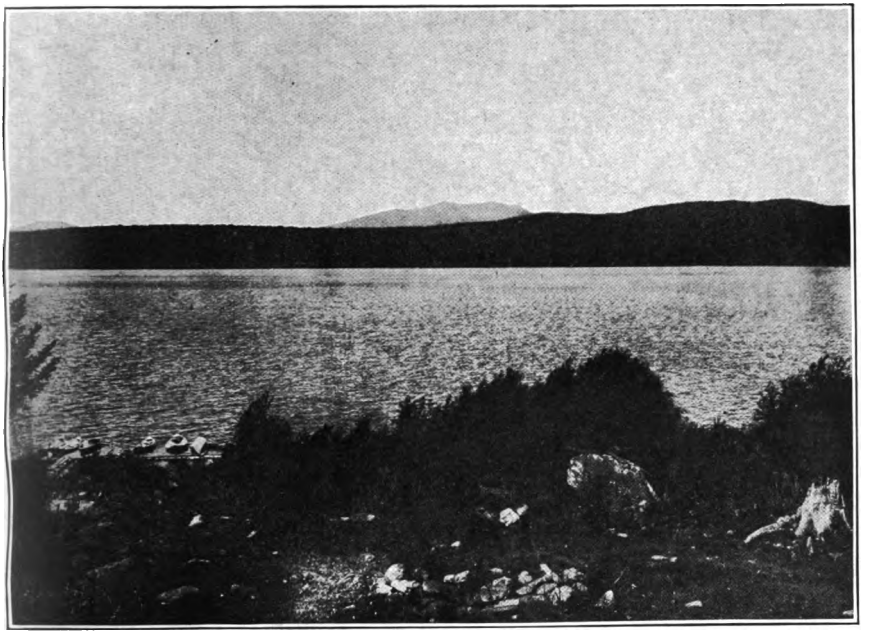
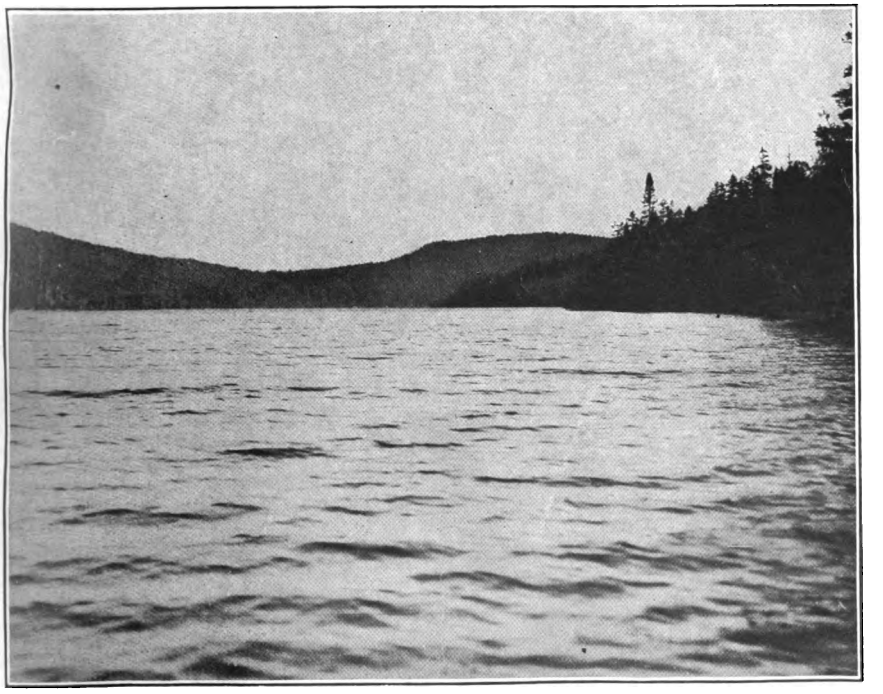


SECOND LAKE.



THIRD LAKE

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nearly anywhere. The mouth of Main Inlet can be traversed by boat for several rods, but occasional crosswise logs must be hauled over. A few small trout were observed in the inlets for some distance up, or until the streams apparently became unsuitable for fish life.

The following table illustrates the distribution of fishes in the principal waters investigated by us as indicated by our observations:

TABLE SHOWING DISTRIBUTION OF FISHES IN THE LOCALITIES STUDIED.

[NOTE.—Names of introduced species are italicized.]

Name.	Localities.						
	First Lake waters.			Second Lake waters.	Third Lake waters.	Perry Stream.	Indian Stream.
	Lake.	Mud Pond.	Round Pond.				
Catostomus catostomus	×			×		×	
Catostomus commersonii	×			×	×	×	×
Chrosomus erythrogaster							×
Semotilus bullaris	×						×
Semotilus atromaculatus		×			×		×
Leuciscus neogæus							×
Notropis cornutus	×			×			
Rhinichthys cataractæ	×			×	×		×
Rhinichthys atronasus	×			×			×
Couesius plumbeus	×	×	×	×	×		×
Anguilla chrisypa	×			×			
Coregonus quadrilateralis	×						
Coregonus clupeiformis	×			×			
Oncorhynchus tschawytscha	×						
Salmo sebago	×			×	×?		
Salmo fario	×						
Salmo irideus	×			×			
Cristivomer namaycush	×			×			
Salvelinus fontinalis	×	×	×	×	×	×	×
Osmerus mordax	×						
Esox reticulatus							
Cottus gracilis	×	×		×		×	×
Lota maculosa	×			×	×		×

LOCAL GEOGRAPHIC RELATIONSHIPS OF THE FISH FAUNA.

NATIVE SPECIES.

The geographic position of these waters would indicate a close faunal relationship to Vermont, Maine, and the neighboring Canadian territory. In fact, some of the tributaries of the upper Connecticut River and probably of Third Lake rise within the Canadian border, and many of them are not far remote from tributaries of the St. Lawrence River, but doubtless there are topographical limits to the intermingling of fishes of these regions. The fish fauna of Connecticut Lakes is markedly different from neighboring Maine waters, the Megalloway River, Parmachenee and Rangeley lakes. It is closer to Vermont, especially Memphremagog Lake, and accordingly to the St. Lawrence basin.

Of the 16 native species of fishes now known to occur in the Connecticut Lakes and tributaries of the upper Connecticut River above Pittsburg, 15 species were collected on this expedition. Of these the

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longnose dace (*Rhinichythys cataractæ*) had not before been recorded from any locality as far east as New Hampshire. The red-bellied minnow (*Chrosomus erythrogaster*) and bronze minnow (*Leuciscus neogæus*) are also new records for New Hampshire, and their occurrence here helps to fill the gap between Maine and the more western localities of their range.

Although the chub-minnow (*Couesius, plumbeus*), brook chub (*Semotilus atromaculatus*), and longnosed sucker (*Catostomus catostomus*) are well known to the inhabitants of this region, we know of no records of their occurrence in New Hampshire, but they were to be expected, since they have been collected in neighboring localities in Maine and Vermont. Of particular interest is the collection of young cusk (*Lota maculosa*), which, so far as we know, have not hitherto been collected in North America.

Species not found by us, but to be expected to occur in this region, are the shiner (*Abramis crysoleucas*) and possibly the Labrador whitefish (*Coregonus labradoricus*).

The following table shows, in parallel columns, the faunal similarity, as exhibited by our collections, of northern Vermont and the upper Androscoggin River and Rangeley Lakes, Maine, with the upper Connecticut River in northern New Hampshire. A cross mark opposite the names of upper Connecticut fishes indicates their presence in the regions represented in the respective columns.

Names of upper Connecticut fishes.	Northern Vermont and Memphremagog Lake.	Upper Androscoggin waters, including Rangeley Lakes.
Catostomus commersonii	×	×
Catostomus catostomus	×	×
Chrosomus erythrogaster		
Semotilus bullaris	×	×
Semotilus atromaculatus	×	×
Leuciscus neogæus		×
Notropis cornutus	×	×
Rhinichthys cataractæ	×	
Rhinichthys atronasus	×	×
Couesius plumbeus	×	×
Anguilla chrisypa	×	×
Coregonus quadrilateralis		
Cristivomer namaycush	×	
Salvelinus fontinalis	×	×
Cottus gracilis	×	×
Lota maculosa	×	

INTRODUCED SPECIES.

From New Hampshire Fish and Game Commission and United States Fish Commission reports, and from letters from the state commissioners and superintendents of hatcheries in New Hampshire, has been compiled a fairly complete account of the artificial or fish-

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cultural distribution of fishes in New Hampshire. It is found that the following species have been planted in the Connecticut Lakes:

Whitefish (*Coregonus clupeiformis*).
Quinnat, or chinook, salmon (*Oncorhynchus tschawytscha*).
Landlocked salmon (*Salmo sebago*).
Rainbow trout (*Salmo irideus*).
"German brown trout" (*Salmo fario*).
"Mackinaw," or "Lake," trout (*Cristivomer namaycush*).
Brook trout (*Salvelinus fontinalis.*)
Smelt (*Osmerus mordax*).

Of these the brook trout and the lake trout are native, as of course is known. The dates of introduction of the other species and number planted will be found under the respective species in the list.

New Hampshire was the first of the states to undertake fish propagation and distribution. The enterprise was taken up with great enthusiasm, and notwithstanding the fact that the state fish commission has been more or less hampered by lack of funds, a vast quantity of young fish have been propagated and introduced into New Hampshire waters. In the early enthusiastic distribution of fish, however, which was somewhat indiscriminate, species were introduced where they should not have been, with occasional disastrous results, the cause of which was not always apparent. Such results may be of at least two kinds: First, to the introduced fry themselves, and, second, to the native fish. Fish introduced into unsuitable waters will, of course, not long survive, and to plant pike, pike perch, or black bass in trout ponds is hazardous. It may be added, too, that caution should be used in planting salmon and lake trout unless they are preferred to other trout already in the waters.

It is a prevalent opinion that since smelts survive, thrive, and increase so prolifically in almost every body of water into which they are introduced, angling is detrimentally affected thereby, for the smelts afford the game fish so much food that the latter do not get hungry enough to take a hook. This is disputed by others, however, who claim that game fishes when feeding will take the hook readily no matter how abundant the food is. In our experience the latter seems to be the case, provided the right kind of lure is used and the fish are there. This suggests the question often asked, "What has become of all the fish planted?" and of the native fish, too, for that matter.

It must be recognized that there are many ways by which lakes and streams become depleted. Logging operations are destructive to fish life in several ways, such as shutting the fish from spawning grounds, destroying young fish by log driving, and by winter fishing to supply the camps with food; and there are but few waters that have not felt the effects of excessive fishing before protective laws were enacted, and from poaching afterwards. Nets, spears, and giant

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powder are not unknown to many northern waters to-day, where the highly esteemed trout, laker, and whitefish abide. It is not a case of sport with those who employ such means to take fish, but a matter of food, and often, too, to those greatly in need of food. These are a few of the factors operating toward the disappearance of native food and game fishes.

Sometimes the reason that introduced fish are never again observed is that the waters are unsuited to them. The water may be too cold or too warm; there may be too many enemies; they may have been all devoured by predaceous fishes that have invaded the waters. In fact it is no unknown occurrence in planting fry to turn them almost into the mouths of chubs and cusk. This sometimes occurs from carelessness, but more often from ignorance of the habits and needs of the young fish. Another reason that introduced fish have not been recorded from waters into which they have been planted is that they often resemble native forms so closely that they have not been recognized when caught, or perhaps they have never been caught, not having been fished for at the proper season of the year and in the right way. Still another reason is that in a large body of water a few survivors of a comparatively few introduced young may escape detection for a long time. All of these things may apply in greater or less degree to the Connecticut Lakes.

Inhabitants of the neighboring country have but a vague idea regarding the nature or appearance of introduced fishes. They are not familiar with the fact that the "Mackinaw trout" is identical with the "laker" or "lunge" native to the lakes; of course the "Mackinaw trout" is never caught, only "lunge," unless it should be in the manner instanced by a resident of this country who having secured 3 fish strange to him thought he had the "Mackinaw trout" because they were different in appearance from anything he had ever seen or read of. His description revealed that he had males of the landlocked salmon. Another instance is of some "trout" caught by a sportsman at Metallak Lodge in a neighboring brook. Persons who had seen young landlocked salmon maintained that the fish were such. They were in fact young "brown trout" (*Salmo fario*). It is not to be wondered at, however, that they were mistaken for salmon, for the resemblance is very close.

It remains, then, to be said that in our opinion, if it is desired to stock the Connecticut Lakes or any one of them with such species as have been introduced, the result can not be accomplished by an occasional plant of a few thousand fry or fingerlings. Many thousand fry or young should be planted every year for several years. Again, the fish should be placed in waters where they will be least likely to be reached by those fishes that would surely devour them, i. e., chub, eels, cusk, etc., and even their own kind if present are not averse to

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cannibalism. The best places to plant fry or fingerlings are in the smaller spring brooks flowing into the lakes or streams. It is unnecessary to say that the brooks should be protected so far as possible. To be more specific, it is suggested that Coon Brook would be an excellent place in which to plant young fish in stocking First Connecticut Lake. West Inlet and Moose Brook would be admirable localities connected with Second Lake. There are no very choice tributary streams of Third Lake, but possibly two little brooks entering the north end would prove satisfactory. The so-called "Main Inlet" in the southwest corner seems wholly unsuitable.

THE FISHES AND THEIR HABITS.

As previously noted, there are but few native species known in these waters. Regarding these, however, there are a few peculiarities worthy of mention. The small size attained by the individuals of some of the species in First and Second lakes is striking, particularly of the long-nosed sucker (*Catostomus catostomus*), chub-minnow (*Couesius plumbeus*), and blob (*Cottus gracilis*). In Vermont the sucker attains a large size, an individual in our collection from Caspian Lake measuring 15 inches in length; specimens from First and Second lakes average 4.62 inches in length, ranging from 3.75 to 5.12 inches. This is especially noticeable, since the other sucker (*C. commersonii*) reaches a much larger size, our collection containing specimens ranging from an inch to a little over 16.25 inches long. The chub minnow is a dwarf compared with specimens from Vermont and northern Maine, Vermont specimens ranging from 4.18 to 4.62 inches long, and northern Maine up to 6 inches in length. In Round Pond and Third Lake, however, this species is considerably larger than in First and Second lakes, specimens measuring a little over 5 inches in length. The blob, or sculpin, in all the localities where it was collected was very small, the largest, a specimen from Mud Pond Brook, measuring less than 3 inches in length, while from the Aroostook River in Maine we have specimens nearly 5 inches, and from a tributary of the Androscoggin River specimens reaching a length of 4 inches. We can offer no suggestion regarding the cause of the diminutiveness of these fishes in First and Second lakes, as most of them seem plump and healthy, though many of the suckers and chub minnows are affected with tapeworms. In some instances the stomach and intestine are so full of them that the abdominal cavity is greatly distended. The question of food supply is one of the first to suggest itself, but there is no evidence that there is more food in Round Pond and Third Lake than in the others mentioned. The result of the study of the plankton and stomach contents of these fishes may throw some light on the subject.

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KEY TO SPECIES.

The following key, although not wholly satisfactory, will be found helpful in identifying the species included in the following list. It is arranged on the alternative plan, and is to be used in the following manner:

Trace the characters of the specimens with what is said under each succeeding letter, until there is a disagreement, or the name of the fish is reached. When a disparity occurs, go to the double of the letter under which it occurs, thence proceed as before until another disagreement or a name is found, and so on.

Example: We have, say, the brown trout and it is not recognized. Compare it with statement *a*. It does not agree, having 2 fins on the back. Turn to *aa*. Two fins on the back agrees; go then to *m*, where the statement also agrees. *n* agrees also; *o* does not; but *oo* does; likewise *p* and *q*. *r* does not, since the outer ventral rays of our specimen are white, and the red spots are surrounded with a light blue areola.

Turn to *rr*, which agrees. The presence of red spots places it in *t*, with which it agrees, and the name follows.

a. One fin on the back.
  b. Ventrals or belly fins present; body not especially elongate, vertical fins (dorsal and anal) not meeting around the tail.
    c. Lips thick, provided with small rounded elevations or papillæ.
      d. Snout long; scales comparatively small, about 104--LONGNOSE SUCKER.
      dd. Snout not very long; scales larger, about 67-------COMMON SUCKER.
    cc. Lips not especially thick and without papillæ.
      e. Scales very small and inconspicuous.
        f. Lateral line, or line of pores along side, incomplete; mouth terminal, oblique.
          g. Two dark stripes along side----------REDBELLIED MINNOW.
          gg. One dark stripe along side----------BRONZE MINNOW.
        ff. Lateral line complete; mouth somewhat inferior and horizontal.
          h. Snout long and prominent, projecting notably beyond the mouth; dark stripe along side if present not especially distinct----------LONGNOSE DACE.
          hh. Snout moderate, projecting but little beyond mouth; a distinct black lateral stripe----------BLACKNOSE DACE.
      ee. Scales larger and conspicuous.
        i. Mouth large, with bands of sharp teeth; dorsal or back fin situated posteriorly----------PICKEREL.
        ii. Mouth not especially large; no teeth; back fin not placed posteriorly.
          j. Breast or forward paired fins (pectorals) not reaching nearly to ventrals.
            k. No black spot at base of dorsal fin in front; scales not small and not crowded on front part of body--CHUB.
            kk. Black spot at base of dorsal in front; scales smaller and crowded on fore part of body------MUD CHUB.

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jj. Pectorals reaching nearly to ventrals.
l. Scales on side deeper than long.....REDFIN.
ll. Scales on side not deeper than long..CHUB MINNOW.
bb. Ventrals wanting; body very elongated and vertical fins meeting around the tail.....EEL.
aa. Two fins on back.
m. Smaller fin posterior to the larger one and without rays or spines (adipose).
n. Mouth large, provided with strong sharp teeth on jaws and tongue.
o. Anal fin with more than 12 rays (14 to 17). CHINOOK SALMON.
oo. Anal with not more than 12 rays (9 to 12).
p. Body spotted.
q. Body with dark colored or black spots; with or without red spots.
r. Pectorals and ventrals without white outer rays; no red spots on side in adult; in young red spots when present not surrounded by another color (not ocellate).
s. No dark spots on tail; no broad rosy or reddish stripe along side; spots on tail, when present, yellowish or orange.....LANDLOCKED SALMON.
ss. Dark spots on tail; usually a broad rosy or crimson stripe along side. RAINBOW TROUT.
rr. Pectorals and ventrals with outer rays white; sides usually with red spots.
t. Back without wavy markings (rivulations or vermiculations) but spotted with rather large dark colored spots.....BROWN TROUT.
tt. Back not spotted, but with rivulation or vermiculations.....TROUT.
qq. Body with light-colored spots, no red spots.....LAKE TROUT.
pp. Body not spotted, but plain dusky, olivaceous, greenish or silvery.....SMELT.
nn. Mouth small, with no teeth in jaws or tongue, except sometimes fine bristle-like teeth (asperities).
u. Body spindle-shape (fusiform) not compressed; snout compressed and pointed, not blunt and flattened at the end (not truncate); ventral sometimes reddish.....ROUND WHITEFISH.
uu. Body somewhat compressed and deep; snout not compressed and sharp, but truncate; ventrals never reddish. WHITEFISH.

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mm. Smaller back fin anterior to the larger one and provided with weak spines or rays.

v. Body not especially elongate; no barbel at chin; ventrals with 3 or 4 rays each.—BLOB.

vv. Body elongate; barbel at chin; ventrals with 7 rays each. BURBOT.

1. LONGNOSE SUCKER. *Catostomus catostomus* (Forster).

Head 4.2 (3.7 to 4.7); eye 5 (4.4 to 5.75); snout 2.25; interorbital 2.2 (1.75 to 2.6); dorsal 10; anal 7; longest dorsal ray 1.4 (1.3 to 1.6) in head; longest anal ray 1.5 (1.45 to 1.85); longest pectoral ray 1.3 (1.18 to 1.44); longest ventral 1.75 (1.7 to 2); scales about 18–104–12.

Body elongate, round and tapering; head long and slender, depressed and flattened above, broad at base, tapering into the long snout which overhangs mouth; lips thick, papillæ in 2 or 3 rows in front, usually 4, sometimes 3 on side; eye moderate, slightly behind middle of head; origin of dorsal midway between tip of snout and base of caudal; lateral line much broken; peritoneum black.

Brownish olive with lower parts white; back and sides with golden or bronze reflections or plain, frequently mottled or clouded with darker, the mottling often assuming the form of irregular cross bars. In breeding males there is often a rosy lateral stripe.

Distinguished from the other sucker by having a longer head and nose and finer scales. Specimens from First Connecticut Lake range in length from 3.75 to 5.37 inches, with an average of about 4.62 inches.

This northern sucker was described from Vermont by Le Sueur as *Catostomus longirostris*. Forster first records it from Canada as *Cyprinus catostomus*. It is sometimes called "red sucker" and "red-sided sucker," owing to the red or reddish stripe that is frequently present along the side in the breeding season. It is also known as "small scale sucker." It is found from New Brunswick and New England westward to the Great Lakes, and northwestward to Alaska. We collected it in Indian Stream, Perry Stream, streams connected with First Connecticut Lake, and in Second Lake. The largest specimens were found in Perry Stream.

This species is regarded as a comparatively deep-water fish, seldom entering shallow water except to breed or feed upon the eggs of other fishes. In many waters it attains a much larger size than it does here. There seem to be two distinct sizes of adult fish. The small one was described by Mather[a] as *Catostomus nanomyzon*. The food of this

[a] Mather, Fred. Memoranda relating to Adirondack fishes, with descriptions of new species, from researches made in 1882. Twelfth Report Adirondack Survey, Appendix, Zoology, 1886, p. 36.

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sucker consists mostly of small animal and vegetable life which it gathers at the bottom, but it has been seen to take insects at the surface and it doubtless will eat young fish. It is known to devour fish eggs. In Perry Stream it was found quite eager for a baited hook and several were caught in that way. The stomach contents of the specimens collected consisted of a considerable quantity of fine algæ, entomostraca, and larval insects. Many larvæ of a black fly were observed; very fine sand was also present. Some specimens were found with stomachs full of fish eggs, presumably of *Couesius*.

The breeding season is in June and July in this region. We found some examples with eggs and milt, but most of them had already spawned by the 1st of July. This species ascends brooks to spawn, at which time the males have small hard tubercles or excrescences on the hinder portion of the body and larger ones on the anal fin and lower half of the caudal. The fish is perhaps too dark to be useful for bait unless it be cut bait. It is most easily caught in quantities in a wire minnow trap or a seine.

2. Sucker. *Catostomus commersonii* (Lacépède).

Head 4.1; depth 5.5; eye 5.2; snout 2; dorsal 12; anal 7; longest dorsal ray 1.56 in head; longest anal 1.3; longest pectoral 1.3; longest ventral 1.85; scales 12–67–7, crowded and much smaller anteriorly.

Body moderately stout, varying with age, subterete, heavy at the shoulders; head rather large and stout; snout blunt, lips strongly papillose, upper not greatly overhanging lower, with 2 or 3 rows of papillæ; eye moderate, high, slightly behind middle of head; origin of dorsal midway between tip of snout and base of caudal; anterior rays of dorsal and anal longest, tip of latter reaching base of caudal; tips of dorsal and ventrals when depressed reaching the same vertical line posteriorly; caudal forked; ventrals not nearly reaching vent; pectoral broadly falcate; lateral line complete, not broken.

Color dusky above, especially on margins of scales; head dusky to upper margin of upper lip and in line shortly below eye to gill-opening, abruptly white below; dark of body beginning just above pectoral and extending in almost straight line to lower base of caudal; pectorals and ventrals pale below, somewhat dusky above; anal pale, dorsal and caudal a little darker than other fins but not so dark as body. The young of this species are somewhat differently colored from the adults: Top of head and upper part of side of head and upper part of body light olive, mottled and clouded with darker brownish olive; mottling most intense on edges of scales; arranged in irregular and indefinite cross bars on back and side; the first bar on nape just back of occiput, second just in advance of dorsal, third at posterior base of dorsal, fourth about midway the space between base of dorsal and base of caudal, fifth on base of caudal, all becoming spotlike, irregular and indefinite on side, but of somewhat darker shade near lateral line; lower parts almost abruptly paler or white; fins all pale; color from a specimen 3.12 inches long. Smaller fish have about the same general color, but the markings are more distinct and definite.

Distinguished from the longnose species by the shorter, heavier head and larger scales.

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This sucker derives many of its local names from its color, appearance and habitat, being variously known as "black sucker," "white sucker," "brassy sucker," "barvel," "barbel," "brook sucker," and "lake sucker." In North America it has an extensive range, being recorded as follows: Quebec, Nova Scotia, New Brunswick, and the Great Lakes, south to Georgia and Missouri, west to Colorado and Montana, and northward to Ungava Bay.

It is the larger of the two suckers occurring in the Connecticut lakes; we have one specimen from Second Lake measuring 16.20 inches in total length. It occurs in all of the waters of this region. It inhabits all kinds of waters from large lakes to small ponds and great rivers to rivulets, and of course varies correspondingly in appearance and size. Its food is usually minute animal and vegetable organisms, though it does not reject larger objects. Young fish have been found in its stomach and it feeds largely upon the eggs of other fish when it can get them. Young fish 1.37 to 1.62 inches long from Indian Stream, August 4, were found to be feeding upon diatoms, desmids, and black fly larvæ. It will frequently take a baited hook, and sometimes is so eager for the bait that it causes annoyance to anglers. It has been caught on a spoon and on the artificial fly, but rarely (only once in our experience). When hooked a large sucker fights vigorously for a short time, then succumbs.

So far as known it is of little use to any water of which it is a denizen, unless it be by eating larval insects. As a food fish it is not of much value, though it is eaten and is said to be of good flavor when taken from cold waters, but rather bony.

Young suckers have not very often been found in other fishes' stomachs, though occasionally a cusk contains one or more. A guide at Second Connecticut Lake informed us that when they were allowed to use "night lines" sucker bait was considered the best for "lunge."

This sucker ascends streams in the spring and early summer to spawn, when in some places it is caught in large quantities with spear or dip net to feed the hogs and fowl, or to use as fertilizer. It usually runs at night, sometimes returning to the lake before daylight, sometimes hiding away during the daytime in deep holes, under banks, or overhanging bushes. The spawning season in Connecticut Lake water had passed before July 1. Like the other species mentioned, adults of this species only a few inches long also occur in small bodies of water, and one of this character was described by Mather as *Catostomus utawana*. But, unlike the longnose sucker, the size varies with the size of the stream or lake in which it occurs.

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3. Red-bellied Minnow. *Chrosomus erythrogaster* Rafinesque.

Head 4; depth 4 (4.2 to 5); eye 3.5; snout 3.8; dorsal 8; anal 8; scales 18–80 to 85–10; teeth 5–5. Body moderately elongate and thick, slightly compressed; head small, conical; snout slightly pointed; mouth moderate, terminal, oblique, the jaws about equal; maxillary reaching nearly to front of eye; eye large, in anterior part of head; lateral line usually ending before reaching as far as vent; origin of dorsal over space between vent and ventral origin, also midway between tip of snout and tip of rays in fork of caudal; caudal forked; anterior base of anal under posterior base of dorsal; ventrals reaching to vent; pectoral not nearly reaching origin of ventrals.

Light olive on top of head and back; cheeks dusky; paler on sides; belly white; black line from nape to base of dorsal, splitting and passing along base of the fin on each side, reuniting behind and continuing to upper base of caudal; dusky stripe from upper posterior part of eye along side, breaking up into spots under dorsal fin, spots continuing nearly to caudal; another broader black stripe from snout through eye to base of caudal, where in small individuals it ends in a small distinct spot; fins and lower parts all pale. In the breeding season the male has the lower fins and belly bright lemon-yellow and sometimes red between the two lateral stripes.

The only fish with which this species is likely to be confounded is *Leuciscus neogæus*, small individuals of which strikingly resemble it. The most prominent external mark of separation is the broken upper lateral stripe and small mouth of the red-bellied minnow. Of internal differences, this species has the lower pharyngeal teeth in one row, and possesses a long intestine, while the other has teeth in two rows and a short intestine.

The only common name for this fish, so far as known to us, is the one given above. The distribution of the species has been given as from New York to the Dakotas and Tennessee. It is common in Maine, and the discovery of it in this region helps to fill the gap between Maine and New York. We found it to be abundant in pools in a meadow or field near Indian Stream on August 4. It is one of the smallest of the minnow family, probably not attaining a length of much over 2 inches. Its long intestine indicates that it is mainly a vegetarian. The stomach and intestines of those examined by us contained mostly diatoms and some larval black flies. The breeding habits of the red-bellied minnow in this region were not observed by us, but in Freeport, Me., it was found spawning in June. It doubtless serves as food for the other fishes. It makes an attractive aquarium fish.

4. Chub. *Semotilus bullaris* (Rafinesque).

Head 4; depth 4; eye 7 (much larger in smaller examples); snout 2.6; maxillary 2.6; mandible 2.6; teeth 2, 4–5, 1; dorsal 8; anal 8; longest dorsal ray 1.3 in head; longest anal 1.75; longest pectoral 1.3; scales 8–51–6.

Body moderately deep, elongate, compressed; caudal peduncle deep; head large; snout rather bluntly conic; mouth large, terminal, somewhat oblique; upper jaw slightly longer; maxillary not quite reaching anterior edge of orbit; eye large in small examples, small in large ones, high up and anterior; origin of dorsal slightly nearer base of caudal than tip of snout, over sixteenth or seventeenth scale of lateral line, edge of fin in a straight line; caudal deeply

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forked; anal similar to dorsal, but smaller; origin of ventral under origin of dorsal, fin not reaching vent; pectoral small, broadly falcate, reaching slightly more than half distance from its posterior base to ventral; lateral line curving abruptly downward over anterior part of pectoral, straight for rest of its course. Description from a specimen 13 inches long from First Connecticut Lake.

Back olive; cheek purplish and brassy; side with brassy or golden reflection; posterior margin of scales black; dorsal and caudal dusky, other fins pale.

Other names by which this widely distributed fish is known are fallfish, windfish, dace, silver dace, and chevin. It occurs commonly in eastern Canada and the United States east of the Alleghenies as far south as Virginia. Its size varies greatly in different waters and in the same waters, but becomes larger northward than in the south. In small streams and ponds it is correspondingly smaller, and in small brooks it reaches maturity when only a few inches long. The chub was common in First Connecticut Lake and the Main Inlet, Perry and Indian streams. It was not obtained in Second or Third Lake or in Round or Mud Pond. In First Lake it could be caught at any time at the mouth of the sewer leading from the lodge, and usually from the wharf. The largest size, however, was not found here, but out in the lake and in the dead water of the inlet large ones were common. They were taken in the lake by trolling; in the inlet on a fly and by gill-net. A gill-net set one night across the inlet took 18 chubs and 19 suckers.

The variation in appearance of the chub at all seasons is almost as great as the variation in size, and in breeding season the sexes differ much in color and somewhat in other respects. Little adult fish resemble young of larger ones, being silvery, and having a dark stripe along the sides. Larger fish are silvery with the stripe showing but faintly or not at all, and still larger ones show no stripe and have dusky posterior exposed margins to the scales. The largest individuals have sexual and age variations, but in general it may be said that in these the colors are more evident and pronounced, the head being black, purple, and blue, yellow with golden and bronze reflections; back olive green; sides purplish or bronze; belly yellowish silvery, or white; posterior margins on lateral scales black. The metallic luster and iridescence is beyond graphic description and the artist's brush can but inadequately represent the varying hues and reflections.

The chub is almost omnivorous, eating everything that a trout will eat and much that the trout will not; if there are sewers or drains entering a lake or stream it will always congregate about the mouths. It will bite more readily than the trout, but is, however, sometimes wary and capricious. Hot sunshiny days are unfavorable for catching large chubs. Small chubs usually take the hook more readily than large ones. As a game or food fish the chub

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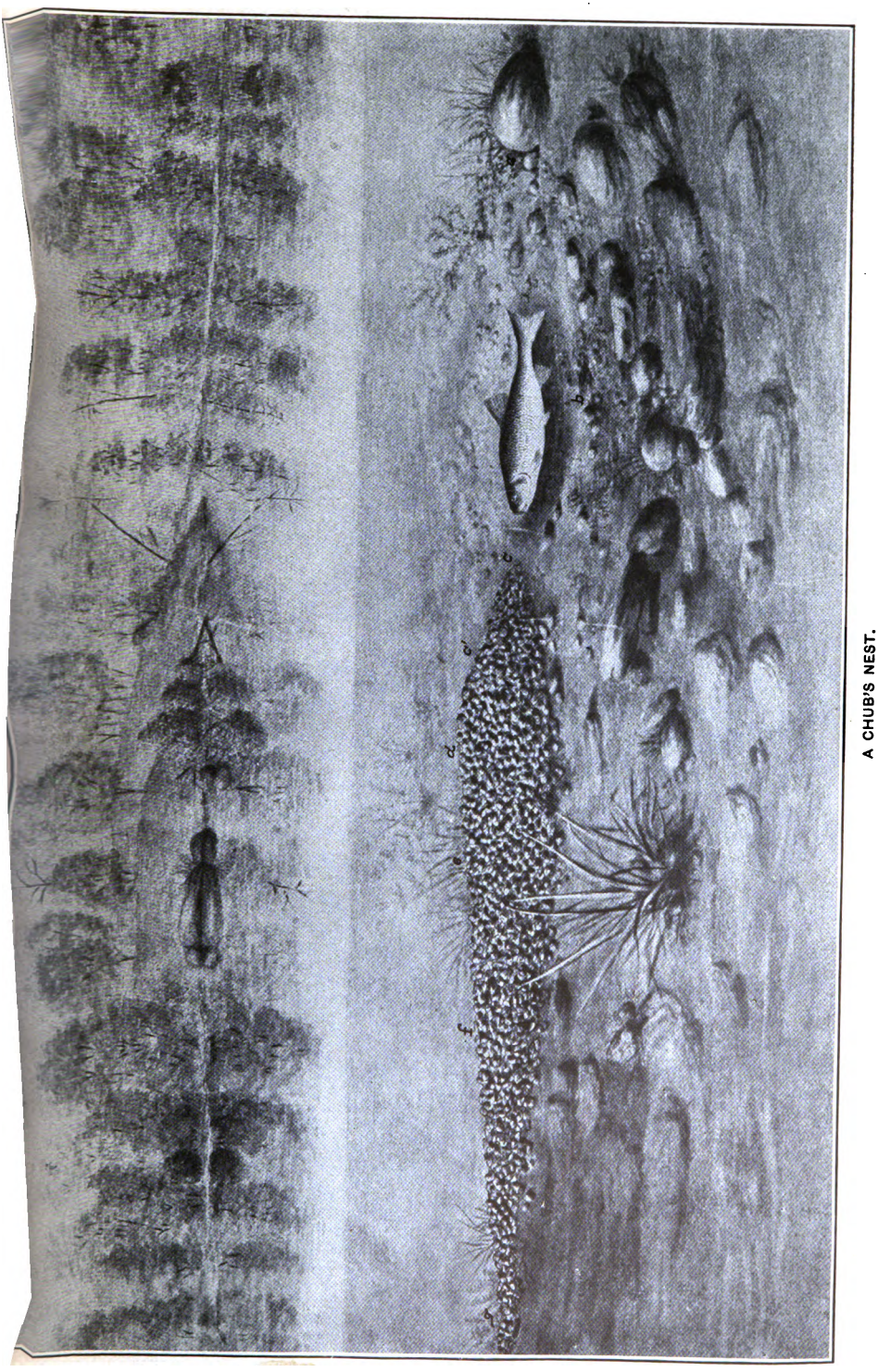

A CHUB'S NEST.
(Diagrammatic.)

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is not highly esteemed. When hooked it fights well for some time, but yields somewhat more quickly than a trout. It will take bait, troll, or fly. Brown or red flies are most attractive. That it is not esteemed as food is due rather to lack of flavor than to a disagreeable taste, and also because other more delectable fish usually occur where the chub is caught. Thoreau says the "chub tastes like brown paper salted."

The breeding habits of the chub are very interesting. Along the quiet reaches of streams or in the shallow waters of ponds or lakes, peculiar heaps of fine gravel or pebbles have probably been noticed by everyone traversing such places. These are the "nests" of chubs. Our attention was first called to this by notes furnished by Supt. Charles G. Atkins, of the United States Bureau of Fisheries Station at Craig Brook, Me., who very carefully recorded the nest-building and spawning process, which description, so closely agreeing with our subsequent observations, is given herewith, as is also a diagrammatic illustration (pl. v).

May 8, 1878.—A small male was seen standing over a hole at the lower end of a heap of gravel 3 feet long by a foot wide, repeatedly driving off other chubs. Later a large male came and drove away the little one, henceforth taking charge of the nest. He was very vigilant, dashing immediately and furiously at every approaching fish, just as landlocked salmon do. After a time he took a pebble in his mouth from *e* and carried it to *d*, where he dropped it. By and by a female came swiftly along, and right over *ed* was seen struggling in an erect position; the male was close to her, but nothing more could be made out. Then the female disappeared. No other fish than this one male remained over the nest.

May 9, 1878.—The same large male was on the nest, but near him over the nest is another small one, which the large one did not this time molest, and which appeared to be a male. The small one was seen to chase others, and when the large one was absent, picked up stones, placing them on the heap; but none of those that appeared to be females lifted a stone. At another time the large male carried stones from about *a* and dropped them at *e* or *d*. His regular stand was over *b;* sometimes he would pick up stones at *c* or *c'* and carry then up to *c'* or *d;* the little one doing the same thing, but sometimes he would carry a stone no more than 2 inches upstream. Several times the large one went up to *g* and returned with stones to *d*. During the observations he was seen to make 15 or 20 trips to a gravel bed 6 or 8 feet distant on the opposite side of the brook and take stones from it and return to his nest. Sometimes he would have but one stone, sometimes several small ones, and rarely a mouth full of very fine gravel mixed with sand. Once he took a stick 3 or 4 inches long and laid it on his nest. He seemed often to eject the burden from his mouth with considerable force; but this appearance may have been from his recoiling the moment he let go the stones. The females, as they were supposed to be, came to the nest several times. In general there was a sudden gathering of a number of fish from the immediate neighborhood, comprising all the chubs within 5 or 6 feet or more, and a simultaneous rush for the nest, where only a confused mass of struggling fish could be distinguished; some of them turned over so that the gleam of the side of their bellies was seen. The old male was always there.

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In this region when these investigations were begun, the chub was through spawning, but heaps of pebbles, some of them containing at least a bushel, were seen in various places along Indian Stream and Main Inlet of First Lake.

5. Mud Chub. *Semotilus atromaculatus* (Mitchill).

Head, 3.7; depth, 4.1; eye 5; snout 2.85; maxiliary 2.5; mandble 2.85; teeth 2. 5–4, 2; longest dorsal fin 1.42; longest anal 1.66; longest pectoral 1.66; scales 10–55–5.

Body stout, dorsal outline slightly arched in front of dorsal, body tapering backward from a point considerably in advance of dorsal; head somewhat thicker than body, short, with an obtuse and moderately declivous snout, the later rather bluntly rounded; mouth broad, oblique, lower jaw slightly included; upper jaw just below lower level of pupil; maxillary not quite reaching front of eye; eye small, high up; scales small, much crowded anteriorly, about 30 in front of dorsal; origin of dorsal over twenty-seventh scale of lateral line; origin of anal slightly in advance of this, under twenty-fourth scale; dorsal and anal similar, the edges forming a straight line; caudal forked; ventrals small, not reaching vent; pectoral small, broadly falcate, reaching slightly more than half the distance from its posterior base to ventral fin; lateral line abruptly bent downward to tip of pectoral, thence straight and nearly median to base of caudal.

Top of head and snout dull steel-blue, cheeks and opercles pale, dusted or sprinkled with olive, back and side olive, with dark margins to scales, most intense and broader posteriorly; side of head, lower jaw, throat, sides of body below lateral line, and belly white or creamy, with dusky or dark grayish margins on scales, same as those above lateral line; scales thus marked extending nearly to level of pectoral, ventral and anal fins; these fins pale with dusky rays; dorsal olive, with jet black spot at base in front; caudal olive, with darker rays; a dark lateral stripe from cheek along side, at first on, then just above, finally on, lateral line to caudal; shoulder girdle just under posterior margin of gillcovers black; a narrow jet black stripe along back from nape, passing each side of base of dorsal to upper base of caudal.

Distinguished from the other chub by darker coloration, scales more crowded anteriorly, and the black dorsal spot; from all other cyprinids in this region by dorsal spot.

This chub bears many local names, but the only one heard in this region is mud chub. The mud chub does not attain so large a size as the common chub, in New England reaching a length of not over 10 inches so far as known, but averaging considerably smaller. The specimens in our collection run from 2.5 to 5.75 inches in length. The recorded range of this species is Maine to southern Missouri, Wyoming, and Canada. In the upper Connecticut region it was collected in Indian Stream, Mud Pond, and outlet of Third Lake just below the lake. It was not found in First Lake, in Main Inlet of First Lake, in Second Lake, or in East Inlet.

The habitat of this species differs in some respects from the common chub, more often being found in brooks and streams, especially in quiet "weedy" places and muddy ponds, yet both not uncommonly occur together.

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The mud chub spawns in early summer, at which time the body of the male becomes of a darker hue and the pectoral and ventral fins are often of a bright orange color, and there are horny excrescences on the snout and top of head. This chub readily takes a hook baited with worm, piece of fish, or any kind of flesh, and frequently an artificial fly.

6. Bronze Minnow. *Leuciscus neogæus* (Cope).

Head 4.11 (3.83 to 4.18) in length without caudal; depth 5 (4.60 to 5.50); eye 4 (4 to 4.50) in head; snout 4 (3.55 to 4.50); dorsal 8; anal 8; scales 85 (82 to 90).

Head rather short, broad, and blunt; snout short, equaling eye; eye large; mouth large, very oblique, maxillary reaching to nearly below front of pupil, jaws even; teeth 1, 5–5, 2. Body stout and chubby; origin of dorsal much nearer base of caudal than tip of snout; scales very small; lateral line of about 17 pores, not reaching a point above insertion of ventrals; dorsal rounded, the middle rays longest; pectoral and ventral pointed; caudal deeply forked.

The above description is taken from a specimen 3.33 inches in length and from 8 other specimens collected in pools in a field near Indian Stream August 4. These 8 were the largest of many collected; they range from about 2 to 3.50 inches long, and are all females. The pharyngeal teeth are uniformly 5 in the main row and 1 or 2 in the other.

Top of head, snout, and back brownish olive with sharply defined edge from upper border of eye to upper base of caudal; a stripe from eye along axis of body to base of caudal, terminating in a small distinct black spot; the area between the dark of the back and the lateral stripe presenting the appearance of a broad lighter stripe from upper posterior border of eye to upper base of caudal; a narrow stripe from nape along median line of back, passing each side of base of dorsal, reuniting behind and continuing to upper base of caudal; entire lower part of body from tip of lower jaw to base of caudal pale; fins all dusky; entire fish with a brassy or bronze luster, whence the name bronze minnow. Males often with red along the side.

Distinguished from the red-bellied minnow, the only fish in this region with which it could be confounded, externally by the larger mouth and the arrangement of stripes. In some specimens the sides of back may be somewhat lighter than at the margin of the dark color, giving the appearance of a second dark stripe bordering the lighter area above the lateral stripe. This is less distinct than in the other species, and if broken up into spots at all it is so broken anteriorly, instead of posteriorly as in *Chrosomus*. This stripe-like appearance usually terminates or blends with the dark color of the caudal peduncle before reaching the base of the caudal fin. Internally this species has well-marked diagnostic characters, having a much shorter alimentary tract and 2 rows of pharyngeal teeth.

In our opinion the generic name *Phoxinus* should be retained for this minutely scaled fish, differing so markedly in this and other respects from other species designated as *Leuciscus*. There is a greater difference between the subgenus *Phoxinus* and other members of the genus *Leuciscus* than there is between *Leuciscus* as a whole (leaving out *Phoxinus*) and *Semotilus*.

The bronze minnow feeds upon small insects, eggs, larvæ, worms, and vegetable matter. The stomachs of some examined contained large amounts of fine algæ. It seems to prefer water characterized

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by the same conditions as are sought by *Chrosomus*, at least they frequently occur together. The only locality in this region in which it was found was in the meadow-spring holes along Indian Stream. That it occurs in other places is likely. It is an attractive bait, and doubtless furnishes food for other species. Its spawning time is in early summer, but its habits have not been observed. It is believed that this is the first time that it has been collected east of Michigan except in a few places in northern Maine and in New Brunswick. It is a handsome minnow, attaining a larger size, about 4 inches, but closely resembling *Chrosomus* in color, and will readily take a hook baited with worm.

7. Redfin. *Notropis cornutus* (Mitchill).

Head 4.12 in length without caudal; depth 4.34; eye 4.80 in head; snout 3; dorsal 8; anal 9; scales 8–44–3.

Head of moderate length, rather deep and compressed, upper profile strongly curved to snout, rounded between eyes; muzzle bluntly rounded; mouth moderate, oblique; lower jaw somewhat included; maxillary not reaching front of eye; eye rather large, high, its lower margin about on level with upper lip; body deep and compressed; scales large, much deeper than long on side of body forward; 24 on back in front of dorsal; lateral line decurved; dorsal high in front; tips of first rays of dorsal when depressed extending slightly beyond the tips of the last; tips of first anal rays not reaching tips of last rays when depressed; pectorals and ventrals pointed; pectoral not quite reaching ventral; ventral reaching vent, nearly to front of anal; caudal forked; peritoneum black. The above description from a male individual 4.68 inches long from Second Lake.

Five specimens from Round Pond ranged in length from about 4 inches to 5 inches, averaging 4.77 inches; head in length without caudal ranged from 3.95 to 4.34, averaging 4.06; depth 3.95 to 4.34, averaging 4.14; eye in head 3.83 to 4.18, averaging 4.03; snout 3.12 to 3.53, averaging 3.29; scales 40 to 42, averaging 41; dorsal rays 8; anal 9; longest dorsal ray 1.21 to 1.36 in head, averaging 1.29.

Upper part of head, back, and sides shiny metallic blue and olive; margins of scales, nearly to belly and quite to anal, dusky, and otherwise somewhat sprinkled with black dots; belly white; an indefinite dark metallic blue stripe along side, most distinct posterior to dorsal; a black stripe from nape along median line of back, passing each side of base of dorsal, reuniting, and continuing to caudal; fins of male margined with red in breeding season, when all tints are more brilliant. Distinguished from other minnows in the region chiefly by the laterally compressed form and the fact that the scales on the front part of side are deeper than long.

Besides "redfin," English appellations such as "shiner," "minnow," "dace," etc., singly or in conjunction with the attribute "redfin" are common. This is, however, preeminently the "redfin" of anglers, although other cyprinids as well as other fishes have red fins at times, and this species does not always have them. The red fins of this fish are nuptial decorations of the male.

The distribution of the redfin is very extensive. According to Jordan and Evermann it inhabits the entire region east of the Rocky

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Mountains except the South Atlantic States and Texas. In First Connecticut Lake it does not seem to be abundant. It is more numerous in Second Lake, where it is said to have been introduced; but the latter statement is unauthentic. There is no evident reason why it should not be indigenous to all these waters, yet it was not secured in Third Lake. It was found in First and Second lakes and in Indian Stream.

The redfin attains a length of 8 inches; the largest obtained here, however, was only 4.87 inches long. It is almost everywhere an abundant species in ponds, lakes, and streams. It is carnivorous, subsisting upon small aquatic animals, insects, etc., like other members of the family, and is not averse to small fishes. In lakes and ponds the redfin lurks around water plants, where its food is most abundant, but on calm evenings it moves about in schools at the surface far from shore, over deep water, feeding upon insects that have fallen upon the water.

Its breeding time is in the spring or early summer, according to the temperature of the water. At this time the male assumes a beautiful coloration, the fins broadly margined with bright red, the back an iridescent blue, and the side reflecting all the hues of the rainbow. A more beautiful minnow can scarcely be conceived. The head of the male at this time bears conical horny tubercles or excrescences, whence the names "hornyhead" and "buckfish." The use of these horns has not been satisfactorily explained. The spawning process is interesting. A small school assembles on a fine gravelly shoal where the water runs swiftly but smoothly just above a riffle. A hollow is formed in the gravel, where the eggs are deposited and fertilized by the male or males in attendance. In the one instance observed there was only one male present.

The redfin will readily take a hook, especially if baited with earthworm. It is also frequently caught on small artificial flies, especially when the fish is feeding upon insects at the surface.

This fish is one of the best live baits, its silvery appearance making it very attractive, and for this reason it is often used to reenforce spinners and spoons, as well as for live bait in still-fishing and in casting.

The best methods of catching the redfin are by minnow traps or with small seine on the shores at the mouths of brooks, particularly where water plants are present.

8. Longnose Dace. *Rhinichthys cataractæ* (Cuvier and Valenciennes).

Head 4.22; depth 4.22 in length without caudal; eye 6.28 in head; snout 2.44; dorsal 8; anal 7; scales 13–59–12.

Head low and broad; interorbital convex, 3.14 in head; snout horizontally bluntly rounded, vertically, or in profile, rather sharp, projecting much beyond small, inferior horizontal mouth; lips thick; eye small, about midway

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between tip of snout and upper end of gill-opening; maxillary not reaching front of eye, small barbel at tip; gill-membrane broadly joined to isthmus, branchiostegals 3. Body robust, plump, and rounded in front, somewhat compressed posteriorly; arched rather abruptly from occiput; lateral line nearly straight, about in axis of body; dorsal moderate, inserted about midway between tip of snout and base of caudal, first rays longest, 1.57 in head, scarcely extending beyond tip of last rays when depressed; first anal rays extending slightly beyond last when depressed; 1.57 in head; pectorals short, 1.4 in head, inserted low, about on level with mouth; ventral short and somewhat rounded, or with rounded angles, and inserted somewhat in advance of insertion of dorsal; scarcely reaching vent; caudal forked.

Described from a female example 4.54 inches in length, from Round Pond Brook August 12.

Seven specimens from this locality ranged in length from 1.54 to 4.54 inches, averaging 3.30 inches. Head in length without caudal ranged from 3.9 to 4.33, averaging 4.11; depth 4.22 to 5.60, averaging 4.11; eye in head 4.2 to 6.28, averaging 5.39; snout 2.14 to 2.85, averaging 2.51; interorbital 3.14 to 3.50, averaging 3.31; scales 59 to 66, averaging 64; dorsal rays 8, the longest ranging from 1.28 to 1.57 in head, averaging 1.36; anal rays 7, the longest ranging from 1.30 to 1.57 in head, averaging 1.47; pectoral ranging from 1.20 to 1.45, averaging 1.34 in head.

Upper part of head, back, and sides bluish gray, much speckled with brown or darker gray, more intense on some scales than others; maxillary, chin, throat, and belly white; dark speckling often grouped, giving a mottled appearance, and so intense on side, especially posteriorly, as to make a more or less definite lateral dusky stripe. Males in spring with more or less crimson, especially on the lower fins.

Distinguished from the other species by the longer, more projecting snout and lacking the distinct jet black lateral stripe of the other; and from all other minnows in this region except the chub minnow by the inferior position of the mouth; from *Couesius* by the more pointed head and sucker-like appearance; also there are only 7 rays in its anal fin, 8 in *Couesius*.

The above is apparently the only distinctive English name for the fish. "Longnose brook minnow" or "rock minnow" may be suggested.

As previously stated, this species has not before, to our knowledge, been definitely recorded from New Hampshire. Jordan and Evermann give its range as "New England to Virginia and Wisconsin; its varieties ranging to Utah and the Columbia basin." It was collected by us in the following places: First Connecticut Lake in mouth of Mud Pond Brook, tributary brook of Main Inlet, Alder Brook, Round Pond Brook, Outlet Third Lake, and Indian Stream.

This minnow is said to attain a length of 5 inches. Our specimens range from 1.25 to 4.54 inches in length.

The favorite habitat of this species is clear rocky brooks and streams. Jordan and Evermann say that it frequents clear and boisterous streams and rock pools, the specific name, *cataractæ*, meaning "of the cataract," the original type being from Niagara Falls. It feeds mainly upon small aquatic animals, such as worms and larvæ of insects, also upon insects that fall upon the water. The inferior

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position of the mouth indicates that it is to some extent at least a bottom feeder. The stomach contents of several individuals from 2.25 to 3.08 inches long from First Lake waters contained fragments of insects, water mites, and insect larvæ. It doubtless eats the eggs of such small fish as breed in brooks and streams where it occurs. It will take a baited hook or a small artificial fly, and is itself a useful bait for large fishes, being hardy and living well in a bait bucket. The spawning time, like that of other Cyprinidæ, is in the spring or early summer, at which time the males are colored somewhat with red.

It is usually hard to get many individuals of this minnow, owing to the difficulty of using a net in the rocky streams where it occurs and its habit of darting under rocks and other shelter for concealment, though a minnow trap in time is effective in getting a fair supply of individuals large enough for live bait. Our largest specimens were taken on a small hook baited with angleworm.

9. Blacknose Dace. *Rhinichthys atronasus* (Mitchill).

Head 4.15 in length without caudal; depth 4.9; eye 4.33 in head; snout 2.60; dorsal 8; anal 7; scales 11–62–7. Head long, rather sharp, mouth small, lower jaw included, somewhat inferior, nearly terminal, slightly oblique; maxillary not reaching anterior border of eye, small barbel at tip; eye large, high, about midway between tip of snout and upper end of gill-opening. Body plumply rounded in front, compressed behind; scales small, lateral line nearly straight, about in axis of body; dorsal nearer base of caudal than tip of snout, the first rays highest, 1.3 in head, extending considerably beyond tips of last rays when depressed; rays of first half of anal longest, 1.23 in head, reaching much beyond the last rays when depressed; pectoral rounded, not reaching nearly to ventrals; ventrals rounded, reaching vent; caudal forked.

Top of head and back green-gray; back and side thickly spotted and dotted with dark brown to lateral line, some of the spots linear, all made up of dots; few round and linear groups of dots below lateral line on side of belly and caudal peduncle; a jet black stripe from snout through eye to base of caudal ending in a black spot on the base of the caudal fin; all below the stripe except the few spots on the side abruptly white; fins all pale.

Description taken from a male individual 2.7 inches long from outlet of Third Lake August 18.

This species varies but little in color. The young have the black stripe more distinct, also a more sharply defined black spot on the caudal. Some individuals have a border above the lateral stripe, of lighter shade than the ground color of the body, and breeding males have broad red borders to the lower fins and sometimes red on the sides, and the light border above mentioned a beautiful golden red hue.

Distinguished from the other dace by the less projecting snout and black lateral stripe extending on the snout; from other minnows of this region by the same characters.

This species of dace does not lack for local names. It is variously known as "rock minnow," "brook minnow," "rock shiner," "pot-belly," "pottle-belly," etc. The last two names are derived from the

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frequent distended appearance of the abdomen due to tapeworms with which the fish seems to be extensively affected.

Its range is somewhat greater than is given by Jordan and Evermann, reaching to New Brunswick and Quebec and in the United States extending south to northern Alabama and west to Minnesota at least, the form running into several varieties. Ernest Thompson-Seton does not mention it as occurring in Manitoba. We collected it in Mud Pond Brook, in Round Pond Brook, in a rivulet affluent of Main Inlet above mouth of First Lake, in Main Inlet at mouth of Coon Brook, at the mouth of East Inlet of Second Lake, along shore of Third Lake, in Third Lake at outlet, and in Indian Stream. It attains a length of about 3 inches and is usually very abundant throughout its range in clear streams. Specimens collected measured from 1.29 to 2.95 inches in length. In the upper Connecticut waters it appears to be less abundant than its congener, although locally it was somewhat more numerous at times. Like the other dace, it feeds upon small aquatic animals and insects.

Young individuals from about 1.29 to 1.66 inches long were found to be feeding upon diatoms, entomostraca, small aquatic worms, and fragments of insects.

The spawning time is in the spring and early summer, when the males assume a more brilliant coloration, more or less red being evident, and often the intensely black stripe seems to be margined with reddish golden or bronze.

The larger individuals of this little species are hardy and make an attractive bait for salmon and trout. They may be caught with a small hook and worm bait, but this is a slow method. The most satisfactory means is by minnow traps; a small seine or dip-net is sometimes effective in brooks that are clear enough, where the ingenuity of the fishermen may indicate ways and means of driving the fish into the nets.

10. Chub-minnow. *Couesius plumbeus* (Agassiz).

Head 4.45 (3.7 to 5.2); eye 3.75 (3.3 to 4.2); snout 3.35 (3.07 to 3.8); dorsal 8; anal 8; scales about 65 (60 to 70) in lateral line, about 34 (31 to 37) before dorsal fin.

Body elongate, not compressed; head flattish above; snout broad, somewhat projecting over the moderate, somewhat oblique mouth; maxillary barely reaching front of eye; barbels on maxillary always evident; eye large, nearly equaling snout; pharyngeal teeth said to be normally 2, 4–4, 2 (in our specimens variously 2, 4–4, 2; 2, 5–4, 2; 2, 4–4, 1; 1, 4–4, 1 and 1, 4–4, 0). Scales small, crowded forward, those on the back smallest; origin of dorsal nearly midway between tip of snout and middle base of caudal, being slightly nearer latter; longest dorsal ray about 1.4 in head, the anterior rays longest; free margin of fins slightly concave; longest anal ray from 1.2 to 1.6, its form similar to that of dorsal; caudal forked; pectoral rounded, reaching nearly to base of ventrals, 1.2 to 1.6 in head; ventrals reaching vent, about 1.6 in head.

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Color, dusky above, sides somewhat silvery, darker above; an obscure dusky lateral band passing through eye and around snout. In the breeding season bases of ventrals and pectoral, angles of mouth and under mouth very distinctly red, the red most distinct in the male; dark lateral stripe also very distinct.

Distinguished from all other minnows in this region, excepting the two daces, by the rather inferior position of the mouth; from the daces by differences noted in diagnosis of longnose dace.

There seems to be no distinctive name for this fish other than the above, which is coined to supply the deficiency. The name seems properly applicable since the fish is a minnow closely related to the chub.

The recorded range of the species is not very wide: the Great Lakes, upper St. Lawrence, northern New York and northern Vermont, Maine, and New Brunswick. It probably occurs in many other places which more extensive collections will reveal. In this region it was almost everywhere common. We collected it in Indian Stream, all three Connecticut Lakes and inlets, and in Round and Mud ponds. In Round Pond and Third Lake it runs somewhat larger than in First and Second lakes, reaching a known length of about 5 inches.

The chub-minnow feeds chiefly upon animal food, as insects, etc. It will also eat small fish; individuals have been found gorged with chopped fish and corn meal, which had been used to attract fishes to the seine. It seems to be very abundant wherever it occurs, being primarily a pond or lake fish, ascending streams in spring and early summer to spawn. In some streams, however, it is a permanent resident. In this region the spawning season seems to be in the early part of July. In Mud Pond Brook, particularly, individuals were found in abundance in spawning condition at this time. In the spawning season the first runs of fish seem to be mostly males, as is the case with smelts; later the runs include both sexes. Many of these fish, but particularly the males, linger in the brooks after the spawning season, which also seems to be the case with many other species of fish. The ascent of streams for the purpose of spawning seems to be mainly at night and on cloudy days, when the fish run in schools. A small unbaited wire minnow trap took from 50 to 100 in a single night. The following is a detailed account of observations upon the runs of this species in Mud Pond Brook near the mouth:

July 2: Thirty-nine caught; many of them showing red markings very distinctly.

July 3 to 5: Trap down 2 nights, took 122, many of the specimens showing red coloration at base of pectorals and ventrals, and at angle of mouth; the dark lateral stripe very distinct.

July 6 to 7: Trap down 2 nights. Several dozen, all in spawning condition.

July 13 to 15: Trap down 2 nights, contained only 22 specimens, most of them spent. The spawning season in this brook seemed to be

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about over by the middle of July, but in a small tributary of Main Inlet on the night of the 15th about 100 were taken in a minnow trap, most of them in spawning condition.

July 18 in this same stream only a few were taken. These were also in spawning condition.

July 22: One ripe male; very scarce in this brook now. Only a few stragglers in spawning condition.

July 26: Only one, spent fish, sex not determined.

August 12: Several caught, all spent, and very thin and attenuated; 4 examples, all spent, were caught in Round Pond Brook.

In this lake these fish are so small that a female carries comparatively few eggs, but the species is, nevertheless, rather prolific. One specimen 4.5 inches long contained 710 eggs.

The proportional numbers of males and females at different periods is indicated by the following notes:

Of 76 specimens taken in Mud Pond Brook on the nights of July 3 to 5, only 4 were females.

Of 35 specimens taken in same place, nights of July 13 to 15, 9 were males and 26 females.

Of 33 specimens taken in tributary of Main Inlet night of July 15, 13 were males and 20 females.

In the lake or pond this species is gregarious. It is most commonly seen about twilight in calm evenings, when the "rises" may be observed everywhere, as it feeds upon small insects at the surface. It may also be seen in schools, rippling the water at the surface as it moves about. In early evening it approaches more closely to the shore; at other times it resorts to comparatively deep water. In First Lake it was taken in a minnow trap in 30 feet of water; in Second Lake it could be caught near the shore at almost any time of day, but best in morning and evening. In Third Lake large schools were observed on August 19 moving about, but chiefly near the west shore, and some were caught on tiny artificial flies. The size and abundance of the chub-minnow make it an important food for game fishes, and it is an excellent live bait for trout and salmon.

11. Eel. *Anguilla chrisypa* Rafinesque.

This fish is so well known that only a few local peculiarities need be noted here. Head broad and flattened, 2.25 in trunk; snout blunt, mouth moderate, the gape 3.8 in head; lower jaw projecting; lips fleshy; eye small, 3 in gape of mouth; interorbital 1.4 in gape.

Color in life very dark olivaceous, almost black; yellowish white on lower jaws and under parts. Described from a specimen 32.25 inches long caught on a hook in First Lake, July 22, near surface where the water was 60 feet deep.

There is no other common name for this fish except some that apply to different sexes, ages or appearance, such as silver eel, broadnose eel, sharpnose eel.

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The distribution of the eel on the Atlantic coast and in the inland waters of eastern North America is pretty extensive, ranging from as far north, at least, as the St. Lawrence River and south to the Gulf of Mexico and West Indies; ascending all rivers within its range, oftentimes to their very sources.

It is very common in the Connecticut Lakes. It was collected in First and Second lakes but not in Third, though it doubtless occurs there. In fresh water the eel sometimes reaches a monstrous size, one weighing 13 pounds having been reported. Those caught in the Connecticut Lakes were not weighed, but 4 specimens measured, respectively, 27.75, 28.75, 32.25, and 33 inches in total length.

In lakes during the daytime the eel remains in rather deep water, approaching the shore at night to feed. Specimens were caught in these lakes in water from 30 to 60 feet deep. Some of them were caught on night lines, others on live bait in stillfishing, at which time some were hooked when not more than 5 or 10 feet below the surface, although the water was about 60 feet deep. The bottom here was soft mud.

The eel subsists upon almost any kind of animal food. It can and does catch live fish for itself and feeds also upon worms, insect larvæ, small mollusks, and not infrequently upon fish eggs when they are obtainable.

The spawning habits of the eel are not fully understood. The sexes are easily distinguished by an examination of the internal reproductive organs, which extend along the backbone and are commonly regarded as fringes of fat. It is claimed by some that only female eels occur in fresh water, which they enter as young fish. When ready to spawn they descend to salt water. Spawning takes place in late fall or early winter, and the females, at least, are said to die after performing that function. In early summer myriads of young eels but a few inches long are observed ascending the streams and rivers. It seems to require a formidable obstruction to stop their progress, nothing short of a cataract sufficing. The very young of the eel before the anadromous migration begins is a peculiar, colorless, transparent, ribbon-shaped larva, called the *Leptocephalus* stage, bearing but little resemblance to an eel.

In winter, in cold localities like New England, the eel burrows in soft mud, and there hibernates. It is a valuable market fish and by many is highly esteemed as food. It is usually caught for the market by means of traps, weirs, and pots, or by spearing in the mud during the hibernation period.

The angler sometimes hooks an eel which by its vigorous pulling, tugging, and shaking causes him to think that he has a trout of generous proportions. But dismay, disgust, and infinite trouble and slime accompany the advent of the capture into the boat.

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12. Round Whitefish. *Coregonus quadrilateralis* Richardson.

Plate VI.

Head 4.67 in length without caudal; depth 4.67; eye 4.60 in head; snout 3.53; maxillary bone 5.11; dorsal 11; anal 11; scales 10–83–8.

Head sharp, upper profile strongly curved downward to snout; snout beak-like, sharp, compressed, projecting; mouth small; distance from tip of snout to posterior extremity of maxillary 4.60 in head; maxillary not reaching front of eye, mandible 2.87; lower jaw included; eye large; interorbital moderate, 3.83 in head; body fusiform, caudal peduncle rather slender; pectoral moderately long, pointed, 1.31 in head; dorsal moderate, first rays longest; 1.43 in head, when depressed scarcely reaching tips of the last ray; margin straight when spread, base 2.09 in head; anal falcate, first rays longest, 1.76 in head, tip when depressed extending considerably beyond tip of last rays, base 2.42 in head; caudal forked.

Top of head and back grayish olive; sides and belly silvery and white; caudal dusky, other fins pale; pectoral tipped with dusky. Description from a male specimen 10.41 inches long from northern Maine, November, 1901. Lower fins of males reddish in life during breeding season.

In this region distinguished from all other fishes but the smelt and salmon family by the presence of the fatty or adipose fin on upper part of tail; from all other members of the salmon family except other whitefishes by its plain coloration; from other whitefishes by its small mouth and "bill"-like snout and fusiform body; from the smelt by its small toothless mouth.

"Billfish" seems to be a local name for this fish restricted to First Connecticut Lake, applied because of its compressed snout, which gives it a beak or "bill"-like appearance. It is one of the whitefishes and is known in the books as "round whitefish" in allusion to its spindle or fusiform shape in contradistinction to the compressed or laterally flattened form of the other species. In Maine it is called the "chiven" or "chivy," a corruption and transappellation of chevaine, the French name for the chub. In some parts of New York it is called the "frost fish," and "menominee" is an aboriginal name. It seldom attains a weight of much over a pound and the average weight is considerably less.

The round whitefish is widely distributed in northern regions, ranging from New Brunswick through New Hampshire, northern Vermont, and the Great Lakes, northward to Labrador and northwestward to Alaska. It was described by Prescott in 1851 from Lake Winnepesaukee, under the name *Coregonus Nov-Angliæ*, "shadwaiter," or "New England whitefish." It doubtless occurs in other New Hampshire waters. It has been reported from First Connecticut Lake under the name of "billfish." In the New Hampshire Fish and Game Report for 1892, page 90, it is recorded from Connecticut Lakes as follows: "They [Connecticut Lakes] are well stocked with minnows and small whitefish (*Coregonus quadrilateralis*), known locally as 'billfish.'" Its occurrence in the other Connecticut Lakes could not be learned of, though there is a reliable report of its captu this year in Main Inlet by hook a[illegible]e at the mouth of Coon Brook.

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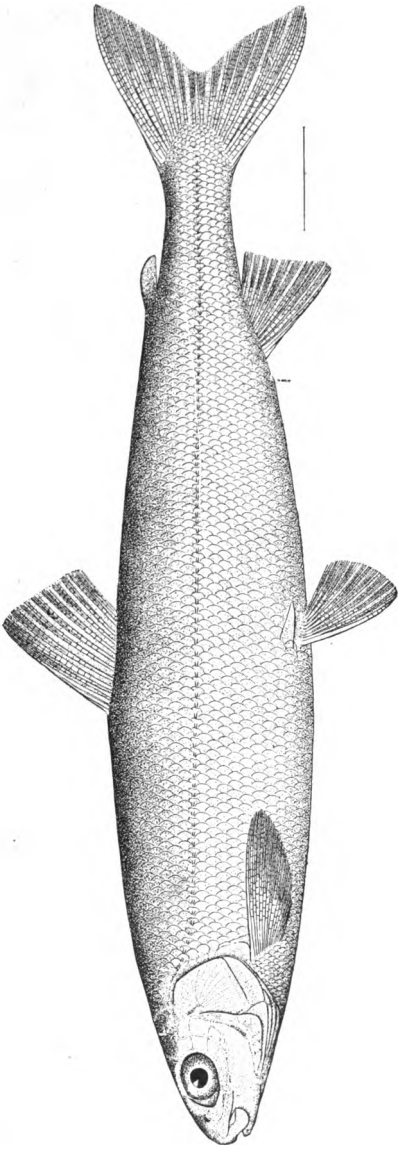

BILLFISH, OR ROUND WHITEFISH (*Coregonus quadrilateralis*).

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It is related that years ago lumbermen used to net this fish in large quantities during the spawning time in this place. It is said not to be abundant now.

In the summer this whitefish, like the other species, affects cool water and consequently usually frequents the deeper water of the lakes. In the early evening in calm weather it approaches the surface, where it feeds upon insects that have fallen upon the water. Its mouth is small, therefore it is not frequently taken on baited hook or fly. It ascends streams to spawn the last of October and first of November. It is said that the spawn is emitted at the surface of the water, one or more males accompanying the female during the act. The eggs are at first semibuoyant, but gradually settle to the bottom and are hatched in the early spring on rising temperature.

The usual method of capture is by nets on the spawning grounds or when the fish is approaching those places. This is an excellent pan fish, and in city markets often appears as smoked whitefish or lake herring, which, when baked or broiled, makes a delicious breakfast dish.

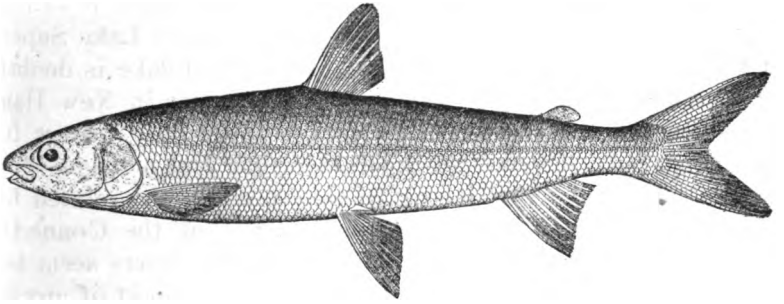

FIG. 1.—Whitefish. Length, 11¼ inches.

13. GREAT LAKES WHITEFISH. *Coregonus clupeiformis* (Mitchill). Plate VII and fig. 1.

Head 4.59 in length to base of caudal; depth 4.34; eye 5.43 in head; snout 4.35; maxillary 3.95; mandible 2.9; interorbital 3.62; dorsal 12; anal 13; scales 10–83–8; gillrakers 10+18 and 11+17 on right and left sides respectively, the longest about 1.64 in eye.

Body rather long and compressed, the back somewhat arched in front; head small and short; snout short and blunt; mouth small, nearly horizontal; maxillary short, broadly ovate; lower jaw included, the blunt snout somewhat projecting; dorsal moderately high, about 1.45 in head; anal about 2.28 in head.

Upper part of head and body dusky olive, punctulate; throat and belly white; membrane of all the fins black.

The above description is taken from a spent female about 19.5 inches long from Umbagog Lake, N. H., collected in the winter of 1903. This specimen is selected because it shows the changes sometimes incident to transplanting and which would most likely be the appearance that the same species would assume in the Connecticut Lakes. A male fish 15 inches total length had the following proportional measurements: Head 4.24; depth 3.52; eye 4.86; snout 3.84; dorsal 11; anal 11; gillrakers 10+18 and 10+17; longest 1.87 in eye. Color about as in the other.

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In the Great Lakes whitefish corresponding measurements vary somewhat and the color is decidedly different, this usually being "satiny white all over; back with faint olive-green shade; fins all white, except the caudal, which is usually slightly dark-edged."

The points of difference between this species and the billfish have been given under the latter species. From its allied form, the common whitefish of Maine (*Coregonus labradoricus*), it is difficult to distinguish it. A slight difference, but one that appears to be constant, is in the upper profile of the head. In *C. clupeiformis* this profile is slightly concave in outline, the posterior part of the head (occipital region) sloping up in conformity to the arch of the back. In *C. labradoricus* this profile is straight, the arch of the back if present beginning abruptly from the upper outline of the occipital portion of the head. There is also an average difference in the number and length of the gillrakers. The small toothless mouth separates it from all other fishes having the gristly or adipose fin on the back behind the rayed fin, and from all the other species it is distinguished by the presence of this fin.

Other names for this fish, used chiefly in the Great Lakes neighborhood, are "humpback whitefish," "bowback whitefish," "highback whitefish," and "Otsego bass," the latter being restricted to Otsego Lake, N. Y.

The general range as given by Evermann and Smith is throughout the Great Lakes region from Lake Champlain to Lake Superior and Lake Winnipeg, but its presence in the latter lake is doubtful. It has been introduced into several bodies of water in New Hampshire, including the Connecticut Lakes, but the only waters from which it has been recorded are Lake Umbagog and perhaps Winnipesaukee. There is no evidence that this species or its related form *Coregonus labradoricus*[a] is indigenous to any of the Connecticut Lakes. The reasons are not apparent, since the waters seem to be well suited to it. There is, moreover, no authentic report of any having been seen since its introduction. The records of the plants, brought from Michigan, are as follows: 1897, 50,000 fry; 1899, 40,000 fry. The latter record does not state definitely that the fish were put into the Connecticut Lakes, but this is to be inferred from the fact that they were delivered at Pittsburg. In 1901, 75,000 or 80,000 fry were planted, making a total of 170,000.

The whitefish has been observed to feed chiefly upon small animals, such as shrimp, water-fleas, small mollusks, worms, insect larvæ, and small fishes. The Maine whitefish has been known to eat its own eggs upon the spawning ground.

The whitefish reaches maturity, according to Evermann and Smith, at the age of 3 or 4 years, and deposits from 10,000 to 75,000 eggs, the number depending upon the size of the fish. The spawning time is in the late fall, chiefly in November. In the summer it retires to the deeper portions of the lakes, but as the time for spawning approaches

[a] Dr. Bean claims that these two forms are specifically identical. See Science, N. S. vol. IX, no. 220, pp. 416–417, March 17, 1899.

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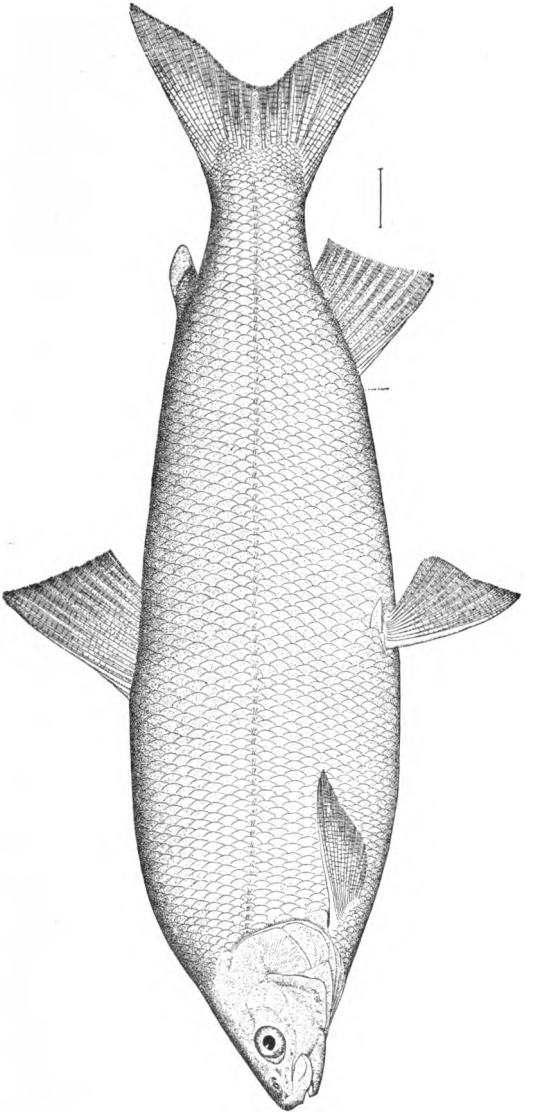

GREAT LAKES WHITEFISH. ADULT. (*Coregonus clupeiformis.*)

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it comes into shoal water about the islands and in the bays and coves. In some waters this fish attains a weight of 10 pounds or more. The Maine whitefish (*C. labradoricus*), native also to some New Hampshire waters, notably Lake Winnipesaukee, differs somewhat in its habits from the description above given. In the summer it is found in cool water, usually in lakes, but not infrequently in streams. In early evening it approaches the surface to feed upon small insects and the like.

The common whitefish is one of the most highly prized food-fishes of fresh waters. In the Great Lakes it is most commonly caught in gill-nets in the fall. It is said to be taken occasionally in those waters on a baited hook or artificial fly. In northern Maine this is a common occurrence with *C. labradoricus*. The latter has been caught in Moosehead Lake by deep fishing with bait and once in a while on a fly; in the Fish River Eagle Lakes of Aroostook County it is taken by trolling with small spoon and hooks baited with worms, and on small artificial flies. To angle successfully for whitefish a light flexible rod

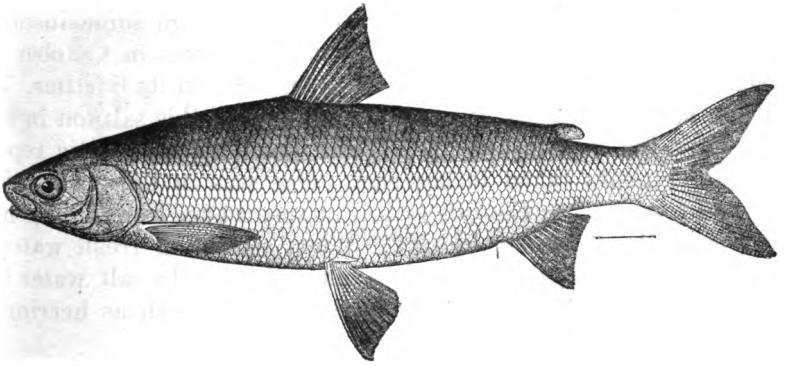

FIG. 2.—Maine whitefish.

and small gauze-winged flies are desirable. The fish is gamy when hooked and will out-rush, out-leap, out-twist, or out-maneuver any other fish of its size. This sport is rendered still more exciting from the care that must be exercised to retain the fish, since the small hook that must be used is easily torn from the tender mouth. The Umbagog Lake whitefish which, as remarked before, are quite positively the results of plants of Michigan whitefish made by either the Maine or New Hampshire Fish Commission, or both, are caught by fishing with small bait through the ice.

14. QUINNAT SALMON. *Oncorhynchus tschawytscha* (Walbaum).

Plate VIII.

Head 4 in length without caudal; dorsal 11; anal 16; gill-rakers usually 9+14; branchiostegals 15 or 16 to 18 or 19, the number on the 2 sides always unlike; teeth comparatively small, longer on sides of lower jaw than in front; vomerine teeth very few and weak, disappearing in the males.

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In the males in late summer the jaws become elongate and distorted, and the anterior teeth much enlarged, the body becomes deeper, more compressed and arched at the shoulder and the color often nearly black. Usual color dusky above, often tinged with olivaceous or bluish; sides and below silvery; head dark slaty, usually darker than the body and little spotted; back, dorsal fin, and tail usually profusely covered with round black spots (these are sometimes few and rarely altogether wanting); sides of head and caudal fin with a peculiar metallic tin-colored luster; male about spawning season (October) blackish, more or less tinged or blotched with dull red. Length 2 to 5 feet; usual weight in Columbia River 22 pounds, in the Sacramento 16 to 18 pounds; in smaller rivers less, but individuals of 70 to 100 pounds have been caught. Easily distinguished from all other Salmonidæ in this region by the larger number of anal rays.

This salmon has various names in the east, such as "California salmon," "Sacramento salmon," and "quinnat salmon," probably the last name the one most generally used. In the west its names are even more numerous: "Quinnat salmon," "tschaviche," "king salmon," "Columbia salmon," "Sacramento salmon," "chinook salmon," "tyee salmon," "tschawytscha." Perhaps "chinook" would be the best, as it is in quite general use. In its native waters this salmon ascends the streams for many miles, in some instances fully 2,000 miles from the sea to spawn. It spawns in October and November and then dies, thus spawning but once in its lifetime.

There have been many attempts to acclimatize this salmon in eastern waters, but without success. There are but 3 authentic reports of adult chinooks taken in the east. One was in Lake Ontario a number of years ago; the others in Sunapee Lake, New Hampshire, and Pierce Pond, Maine, in 1906. When ascending fresh water to spawn it does not feed and will not take a hook. In salt water it is caught by trolling with artificial lures and bait, such as herring or squid.

In 1904 several thousand fry were planted in First Connecticut Lake waters. On July 7 we took in a minnow trap in Mud Pond Brook, near the lake, 1 specimen about 2 inches long. These fry are distinguishable by the large number of anal rays, though in general appearance they greatly resemble a landlocked salmon. They are, however, somewhat deeper and relatively shorter. There are 9 or 10 vertical spot-like parr marks on the side and smaller close-set spots on the side of the back.

15. Landlocked Salmon. *Salmo sebago* Girard.

Plate IX.

Head 4.36 in length without caudal; depth 3.58; eye 7.74 in head; snout 3.45; maxillary bone 2.09; dorsal 12; anal 9; scales 20–116–21.

Head comparatively short, bluntly conic; mouth moderate, sharp teeth on jaws, vomer and palatines; vomerine teeth in a single row on shaft; distance from tip of snout to posterior extremity of maxillary 2.21 in head; lower jaw slightly hooked, mandible 1.72 in head; branchiostegals 11 on right side and 12 on left; gillrakers 8 + 13 on right side, 7 + 13 on left, longest 2 in eye. Body

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QUINNAT SALMON (*Oncorhynchus tschawytscha*).
Upper figure from a young example 4 inches long.

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rather deep, somewhat compressed; caudal peduncle comparatively short and deep. the distance from adipose to upper base of caudal 2.38 in head; distance from posterior base of anal to lower base of caudal about 1.93; least depth of caudal peduncle about 1.13 in first distance, 1.39 in the other and about 2.70 in head; pectoral moderate, 1.47 in head; longest dorsal ray much longer than base of fin, reaching when depressed to about the middle of the last rays, their length 1.78 in head; base 1.82; first rays of anal longer than base, the tip reaching, when depressed, the tips of the last rays; length 1.93 in head; base 2.48; ventral rather short, 2 in head; caudal deeply lunate.

Top of head and back olive-green, most intense on edge of scales; side of head and body to level of lower fins iridescent silvery; ventral region from tip of lower jaw to base of anal white; scales on side of body below lateral line punctulated with dusky; large round black spots on side of head; tip of lower jaw black; large irregularly formed black spots on side of body nearly down to level of pectoral forward, none below lateral line posteriorly; shape of spots determined much by the scales occupied, being more or less definitely blotch-like, × and ××, crescentic and double crescentic; largest spot covering 6 scales; dorsal olive, 2 rows of dark spots along lower part; adipose dark olive; caudal olive; pectoral white below with dusky margin, first ray dusky olive; ventral white below, somewhat dusky above; anal soiled white.

Description from a male specimen 20 inches long caught in June, 1903, in Sebago Lake, Maine.

The following notes were from 2 specimens in breeding condition, taken in Grand Lake Stream, Maine, November, 1899:

(1) Male, 23.75 inches total length; head in length without caudal 3.56; depth 4.44; eye 9.12 in head; snout 2.31; maxillary bone 2.70; dorsal 12; anal 9; scales 24–116–23; head long, snout slightly curved; mouth large; distance from tip of snout to posterior extremity of maxillary 1.85 in head; lower jaw hooked, fitting into socket in upper; mandible 1.56 in head; gill-rakers 7+12 on right side and 8+12 on left; branchiostegals 10 on right side, 12 on left; body comparatively deep and somewhat compressed; caudal peduncle short and deep; length of dorsal base 2.24 in head, slightly longer than longest ray, which is 2.26 in head; length of anal base considerably shorter than longest ray, 3.24 in head; longest ray 2.7 in head; pectoral moderate, 1.71 in head; ventral equal in length to base of dorsal, 2.24 in head; caudal broadly emarginate.

Top of head and back as far down as lateral line olivaceous; side of head greenish and dusky; variously shaped spots, of greatest intensity on edges of scales, some of them ×-shaped, along the sides, dark brown and almost black, bordered by light brown, those on lateral line with red center; few large brown spots on cheek; indistinct chrome yellow below lateral line; dorsal fin dusky olive, with 2 rows of dark-brown spots along the lower part; pectoral dusky outside, greenish within, with broad dusky marginal band on tip; ventral the same; caudal dusky olive-green; chin dusky; throat white, isthmus slaty; belly white with dusky blotches.

(2) Female, 23.33 inches in total length; head 4.95 in length without caudal; depth 5.18; eye 6.82 in head; snout 3.05; maxillary bone 2.63; dorsal 11; anal 9; scales 23–116–25; head, snout, and lower jaw much shorter than in male; mouth smaller; distance from tip of snout to posterior extremity of maxillary 1.96 in head; lower jaw not hooked, length of mandible 1.70 in head; gill-rakers 7+12 on each side; branchiostelgals 11 on right, 12 on left side; body moderately deep and not compressed; caudal peduncle short and deep; caudal broadly emarginate; longest dorsal ray much shorter than base, 2.03 in head; base 1.75;

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anal base longer than its longest ray, 2.23 and 2.36 in head, respectively; pectoral 1.47 in head; ventral 2.03.

Back dusky with silvery luster and numerous black and dark-brown spots, some with faint aureola of brownish; large round ocelli on cheek and opercles; shape of spots on side determined by the scales occupied by the spot; ×, ××, and double crescent-shaped, and others variously irregular; few faint orange spots on caudal peduncle; general tone silvery with dusky blotches; dorsal with rows of black spots; adipose and caudal dusky olive.

The above descriptions were taken from fresh dead specimens; therefore the general shades are somewhat darker and bright colors more subdued than in living fish. These are good average descriptions of fair-sized salmon, but comparatively large for the region whence they came. In structure and color the fish from the same locality vary considerably; those from different localities vary much more; therefore, in comparing specimens with these descriptions due allowance should be made for the variations.

Distinguished from all other members of the salmon family occurring in this region, or introduced, by the general color. It is most likely to be confused with the brown trout. The presence of white outer or first rays of the ventral fins in the latter amply serve to distinguish the one from the other.

This fish is otherwise known as "salmon trout," "blackspotted trout," "white trout," "schoodic salmon," and "Sebago salmon." Lately, in parts of Maine, the name "ouananiche," which belongs to another species, has been erroneously applied to this. "Landlocked salmon" is a misnomer; it is, moreover, not euphonic, and long custom alone partly justifies its use; "fresh-water salmon" would be more appropriate.

This species is naturally restricted to 4 river basins in Maine, and to a limited area in each, and to one or two localities in New Brunswick, if the fish found there is the same species. In its native waters its existence seemed to depend in some way upon the presence of smelts. It is an introduced species in the Connecticut lakes, and has been successfully acclimated in waters to which it was not indigenous, especially in New England and New York. In the Connecticut Lakes introductions of young have been made as follows:

Second Lake:		First Lake—Continued:	
1879	80,000	1896	20,000
1888	40,000	1900	12,000
1888	20,000	1901	17,000
First Lake:		1903	1,000
1892	25,000	1904	10,000
1895	20,000	1906	834

In the report of the New Hampshire Fish and Game Commission for 1892, page 90, the following statement appears:

There were transferred to this hatchery [Colebrook] 25,000 eggs of the landlocked salmon. The young fry were planted in tributaries of the First Connecticut Lake. The former plants of salmon made in this lake showed up this season finely, many fine specimens weighing from 4 to 6 pounds being taken. The waters of these lakes are well adapted to this king of game fishes. They

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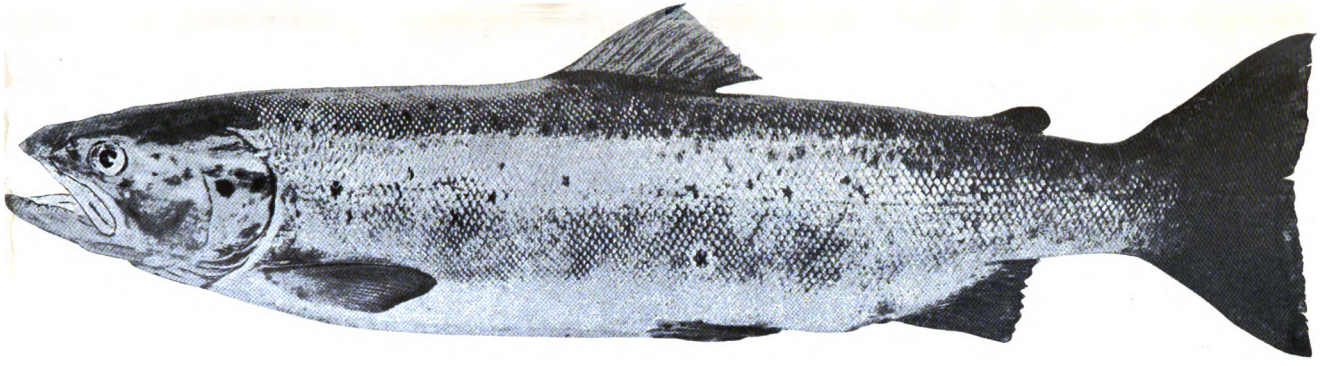
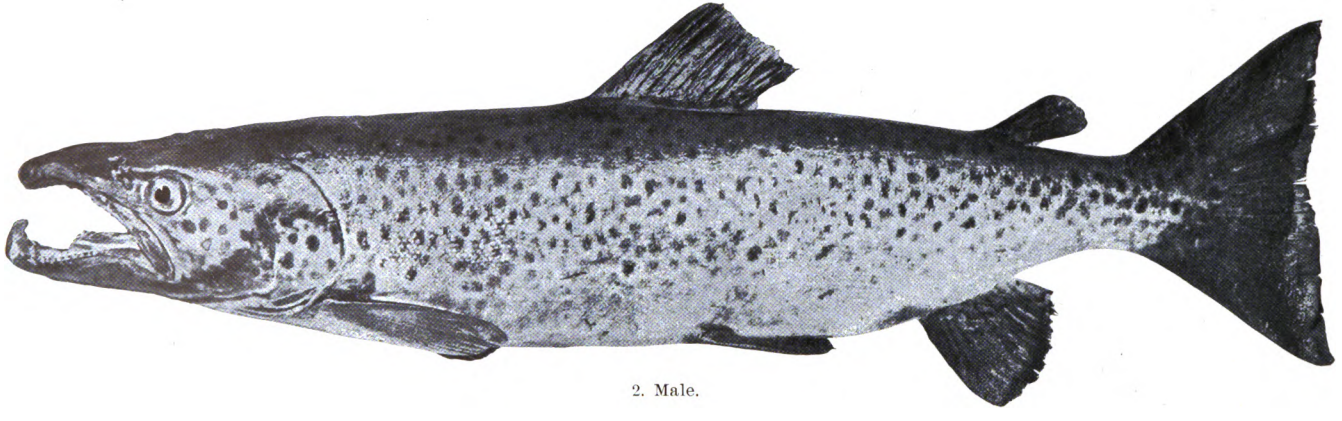


1. Female.



2. Male.

BREEDING LANDLOCKED SALMON (*Salmo sebago*).

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are well stocked with minnows and small whitefish (*Coregonus quadrilateralis*), known locally as billfish. The stream flowing into these lakes are free from sawdust, and afford fine spawning grounds for adult salmon.

Some salmon are caught every year, but nothing could be learned regarding the abundance in the lakes.

The salmon subsists upon fish and insects and, as indicated before, in its native waters particularly upon smelts. In some waters this relation to smelts to a great extent determines the time and method of angling for the salmon. In the spring, when the smelt ascends streams and brooks or approaches the shore for the purpose of spawning, the salmon follows it and feeds greedily upon it. The salmon is then taken by trolling, with any bright lure, but mainly hooks or spinners, with a smelt or shiner bait. At this season it may be caught also by casting a bait, or sometimes a fly, in streams, where it seldom lies in an eddy or pool, but just in the edge of the swiftest flowing water, feeding upon fish as they appear, or aquatic larvæ of insects, and occasionally insects at the surface. When taking bait it is sometimes, but not always, rather particular or capricious. Sometimes any kind of a bait, from a tinsel imitation of a fish or a bunch of earthworms to a spinner or smelt, is acceptable. Again, it will take only one or the other; at other times, if it will take anything at all, it may take only artificial flies and only certain kinds of these; the killing flies of any body of water must be learned by experience. In some water bright flies like Scarlet Ibis, Silver Doctor, and the more somber Jockscot are killers; in others only plain flies will attract the least attention. They may be dark or light, but without much, if any, red or other bright color. The salmon in some waters may be caught all summer and into September; in others it seldom bites much after the first part of July, and in September it begins to run to the spawning grounds, the run continuing well into November. The spawning, as a rule, takes place in November and the eggs hatch in the following spring. In most instances, if possible, salmon ascend or descend streams, to spawn upon gravelly bottoms in quickly running water. When streams are not available the operation takes place on gravelly shoals of the lake. In such places a hollow is made in the gravel, which serves as a nest. These are sometimes termed "redds."

There are more or less structural and chromatic changes in the fish at the approach of the breeding season. The jaws of the male are prolonged, the under jaw becomes hooked, owing to a cartilaginous knob which fits into a socket in the snout, but in some cases it passes up over the end of the snout. The hooked lower jaw of the male persists for a long time, the long-jawed hungry fellows being frequently caught in the spring. In many instances the fierce appearance of these fish have caused them to be mistaken for or regarded as other

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species. The colors of both sexes become brighter, brown, orang and yellow and blue appearing on the bodies, especially the male, an faint orange spots appear on the tail, which at other times is spotles The salmon practically cease feeding at this time. They probabl do not breed oftener than every other year.

The salmon of First Connecticut Lake probably spawn in the Mai Inlet. Judging from their size, young salmon remain on the spawn ing grounds or in the streams for one, two, or even three year Salmon parrs frequently have red spots on the side.

By many it is considered necessary to screen lakes to retain land locked salmon. This seems wholly unnecessary unless it is desire to restrict *all* to the lake. Some young salmon will be carried down stream by freshet, and under favorable conditions others will vol untarily go down into outlets of lakes, but will not traverse un congenial places for any great distance. Occasionally one or more perhaps, may make their way to salt water, but not in sufficient num bers to deplete the lake. Then, too, the screens usually employed wil prevent only large fish from entering the outlet, and not being fin enough to prevent young salmon from passing through are, therefore a useless expense.

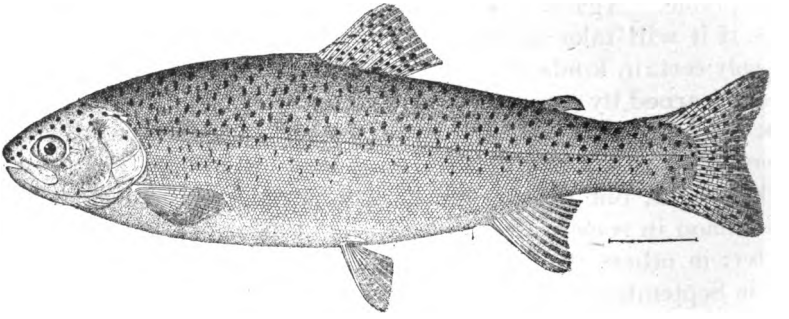

FIG. 3.—Rainbow trout, female.

16. RAINBOW TROUT. *Salmo irideus* Gibbons.

Plate x and fig. 3.

Head 4.66 in length without caudal; depth 3.50; eye 4.66 in head; snout about 4; dorsal 11; anal 11; scales 21–135 to 140–20.

Head short and deep; snout short; mouth large, maxillary not quite reaching to below posterior margin of eye; vomerine teeth in 2 irregular rows; body short and deep; caudal peduncle rather deep, about 2 in head; dorsal origin a little nearer tip of snout than base of caudal; length of dorsal base 7.5 in length of body without caudal, slightly exceeding longest ray; last dorsal ray 2 in longest; anal base a little less than 2 in head, the longest ray about equaling longest dorsal ray.

Upper parts greenish blue, sometimes purplish; sides more or less silvery, and profusely spotted with small black spots which are most numerous above the lateral line; head, dorsal, adipose, and caudal also black-spotted. In the spring breeding season the broad crimson lateral band becomes brighter, and the sides of both sexes are iridescent purplish. (After Bean.)

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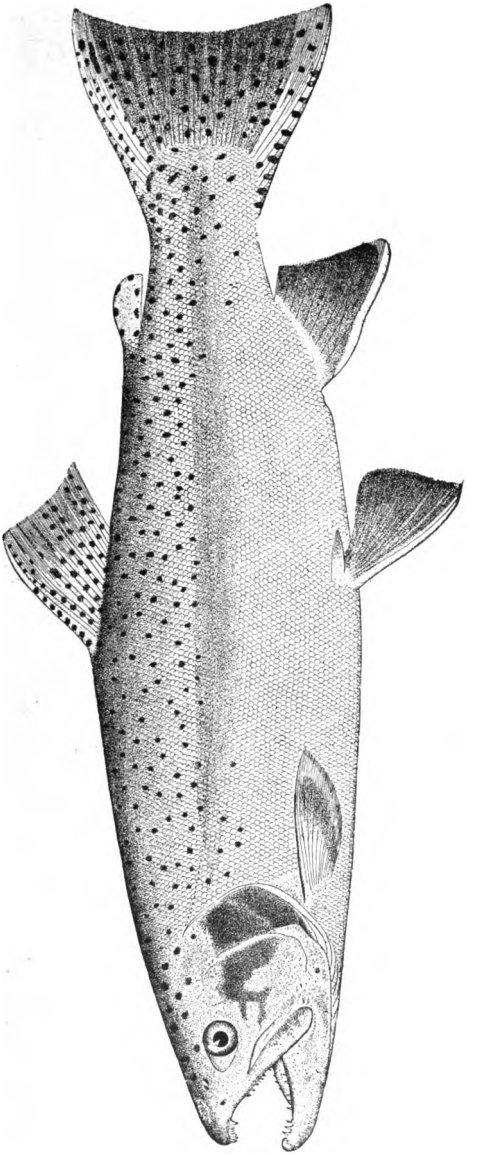

RAINBOW TROUT. MALE. (*Salmo irideus.*)

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Rainbow trout is the name in most general use for this fish. Other names are chiefly those of localities in which the trout or its varieties occur. It is a native of the mountain streams of the Pacific coast, occurring from California to Central Alaska. It is not native in the East, though in some of the states it has become fairly well acclimatized. It does not, however, seem to have been successfully established in New Hampshire. There are unauthentic reports of its having been taken in upper Connecticut waters, the most positive being that of Mr. Bumford, who said that several years ago he placed rainbow trout in East Inlet of Second Lake, and landlocked salmon in Third Lake, and that five years ago he saw 2 rainbows caught in a pool below First Lake dam, one of them weighing 5 pounds.

The following plants of rainbow trout have been made in the Connecticut lakes. It could not be ascertained whether fry or fingerlings were planted or in what particular waters they were placed:

1895	20,000	1901	25,000
1896	20,000	1902	25,000
1901	50,000	1904	18,000

According to Bean "the average individuals of this species are less than a foot in length, but specimens measuring more than 2 feet and having a weight of 13 pounds have been recorded. At Neosho, Mo., the young have been artificially grown to a length of nearly a foot in a year."

The rainbow trout feeds on worms, insect larvæ, and salmon eggs. In streams in which the California salmon and rainbow exist together, the rainbow is more destructive to the salmon eggs than any other species. Spawning takes place in winter and early spring, varying with temperature and locality. The bulk of the eggs are usually taken in January, February, and March, and the average yield from each female is about 900 eggs. A few of the females spawn when 2 years old, but about one-half of them begin at 3 years. The egg is from one-fifth to two-ninths inch in diameter; it has a rich cream color when first taken, changing to pink or flesh color before hatching.

This species will live in water of a much higher temperature than the brook trout will endure and it thrives in tidal streams and even salt water.

The rainbow trout is a lively and acrobatic game fish. It is preeminently a fly fish and a good-sized one on a light fly rod will tax the skill of the angler and cause more of the proverbial ecstatic thrills than almost any fish of its size, excepting perhaps the steelhead, which, by the way, might be more successfully cultivated and acclimatized in New England waters than the rainbow, as it has become well established in the cold waters of Lake Superior.

The rainbow is highly esteemed as a food fish.

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17. Brown Trout. *Salmo fario* Linnæus.

Head 3.8 in length; eye 5 in head; snout 3.7; distance from tip of snout to end of maxillary 1.8; distance from tip of snout to end of maxillary bone 2.35; gillrakers 5+11; branchiostegals 10; dorsal 10; anal 9; longest dorsal ray 1.5 in head; longest anal ray 1.6; longest pectoral ray 1.44; scales 140.

Body comparatively short and stout; head moderate; eye small; mouth large; maxillary reaching beyond eye; caudal peduncle deep, about 2.5 in head; origin of dorsal fin slightly nearer tip of snout than base of caudal, its outer edge straight; caudal fin nearly truncate, slightly emarginate in small examples; anal similar to dorsal, its posterior base directly under posterior base of adipose fin; origin of ventrals under last third of dorsal, tips not reaching vent; pectoral moderate, falcate.

General color in life, top and side of head and back as far down as lateral line light olive with metallic lustre; side of back and side, as far as lateral line, with black and dark brown spots; top of back without spots; below lateral line to level of ventral fins light olive and light golden yellow; belly white; large black spot on preopercle and several smaller black spots on opercle; along sides, immediately above and below lateral line, light orange spots, ocellated

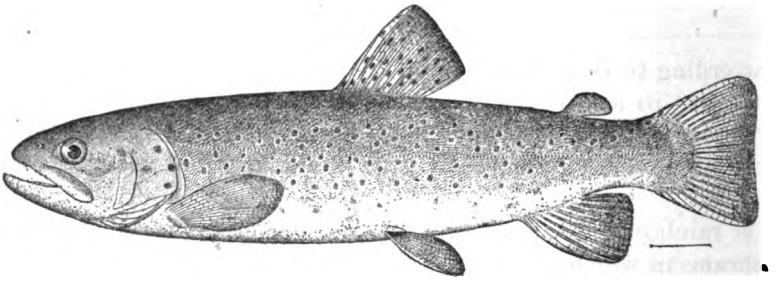

Fig. 4.—Brown trout.

with very pale blue; dorsal fin with numerous black spots, fin grayish olive, tip of first 3 or 4 rays lighter gray; other fins yellowish olive; first ray of anal white, margined posteriorly with dusky streak; no spots on caudal; adipose fin plain; tips of jaws dusky; throat and under part of lower jaw white; parr marks evident at times, about 11 in number; very faint large dusky spots below posteriorly.

Description from male specimen 9 inches in total length.

Distinguished from the common trout by having spots on the back instead of wavy markings or rivulations, and the vomer with teeth on the shaft, not in a group at the head as in the common trout. Distinguished from salmon by the presence of white margins to ventral and anal fins.

The "brown trout," "German trout," "German brown trout," or "von Behr trout" is the common brook trout of Europe. In Great Britain it is the "brown trout" or "yellow trout." It was introduced into this country from Germany in 1883, according to Bean[a], through the instrumentality of Herr von Behr, president of the Deutscher Fischerei Verein:

[a] Bean, T. H. Fishes of New York. Bulletin 60, New York State Museum, 1903, p. 256.

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It is now well established in New York, Pennsylvania, Maryland, Missouri, Michigan, Wisconsin, Nebraska, Colorado, and several other states. This trout has proved to be well adapted to the region east of the Rocky Mountains, which has no native black-spotted species, though the western streams and lakes contain many forms in a high state of development.

Size.—Under favorable conditions the brown trout has been credited with a weight of 22 pounds and a length of 35 inches. In New Zealand rivers, where it was introduced with unusual success, it now approximates equal size; but in most localities 10 pounds is about the limit of weight and 5 or 6 pounds is a good average, while in some regions the length seldom exceeds 1 foot and the weight ranges from one-half to 1 pound. In the United States a wild specimen, 7 years old, weighed about 11 pounds. In a well in Scotland an individual aged 15 years measured only about 1 foot in length. These illustrations will serve to show how much the growth of a brown trout is affected by its surroundings and food supply. The species has been known to become sexually mature when 2 years old and 8 inches long.

Habits.—The brown trout thrives in clear, cold, rapid streams and at the mouths of streams tributary to lakes. In its movements it is swift, and it leaps over obstructions like the salmon. It feeds usually in the morning and evening, is more active during evening and night, and often lies quietly in deep pools or in the shadow of overhanging bushes and trees for hours at a time. It feeds on insects and their larvæ, worms, mollusks, and small fishes and like its relative, the rainbow trout, it is fond of the eggs of fishes. In Europe it is described as rising eagerly to the surface in pursuit of gnats and is said to grow more rapidly when fed on insects.

Reproduction.—Spawning begins in October and continues through December and sometimes into January. The eggs are from one-sixth to one-fifth of an inch in diameter and yellowish or reddish in color; they are deposited at intervals during a period of many days in crevices between stones, under projecting roots of trees, and sometimes in nests excavated by the spawning fishes. The parents cover the eggs to some extent with gravel. The hatching period varies according to temperature from forty to seventy days. Females aged 3 years furnish on the average about 350 eggs each, but individuals of this age have yielded as many as 700, and even at the age of 2 years some females produce from 400 to 500. When they are 4 or 5 years old, the number of eggs has reached 1,500 to 2,000. The young thrive in water with a temperature of about 50° F. Sterility in the females is common, and the breeding females have been observed to cease reproduction when 8 years old.

Qualities.—The brown trout is in its prime from May to the last of September. Its flesh is very digestible and nutritious, and deeper red than that of the salmon when suitable food is furnished; the flavor and color, however, vary with food and locality. Insect food produces the most rapid growth and best condition. This species has been so long known as one of the noblest of the game fishes and its adaptability for capture with artificial flies because of its feeding habits is so well understood that I need not dwell on these familiar details.

This species was introduced into Connecticut Lakes as follows: 1894, 20,000; 1901, 170,000. Although the precise locality is not certain, it was probably in Mud Pond Brook. It is uncertain whether all of those collected are the individuals planted or some or all of them offspring of the planted fish. The great difference in size would seem to indicate that at least the small ones were offspring

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or the second generation. The specimens run from about 4.25 to 9 inches in length. The food, as indicated by the stomach contents, consisted of small insects and caddis worms or larvæ with wood and fine gravel cases. Individuals about 5.75 inches long were sexually mature males and one about 6 inches long a female with eggs.

Should further plants of this fish be made in the Connecticut Lake waters it is suggested that they be restricted to the immediate waters of the First Lake, and that they be placed in the lower end of Coon Brook near Main Inlet and in Big Brook near the road to Second Lake. Both of these places can be conveniently reached, the one by boat, the other by team. The advantages of these places are that owing to the tendency of the trout to remain in the waters in which planted it would attain a larger size in these brooks and perhaps would be more likely to work out into the Main Inlet and thence to the lake, where it would reach a still larger size.

17. Lake Trout. *Cristivomer namaycush* (Walbaum).

Plate xi.

Head in length to base of caudal 3.79; eye in head 7.58; snout 5.05; maxillary bone 2.45; mandible 1.59; gillrakers 8+13 on each side; the longest about 1.7 in eye; branchiostegals 12 on right side and 11 on left; dorsal 11; anal 10; scales 32–180–32.

Head comparatively long; eye small; distance from tip of snout to posterior extremity of maxillary 1.97 in head; body rather more slender than that of the trout or salmon; pores of lateral line about 120 in number; pectoral moderate, 1.68 in head; first rays of dorsal and anal longest, much overlapping the others when depressed, especially in the anal; caudal deeply forked.

Head, back, and upper parts of side dark greenish gray, the color most intense on edges of scales, clearly defining their outline; belly silvery white with darker shade defining margins of scales; light golden yellow spots on cheeks and opercles and all parts of body except ventral region, from tip of lower jaw to base of anal, the spots lighter posteriorly; dorsal olive, spotted with pale yellow and broadly margined with same shade; pectoral and ventrals pale yellow below, dusky above with broad margin of pale yellow; anal dusky, with ends of rays pale yellow, first rays white; adipose and caudal dusky, spotted with greenish yellow. Description taken from a male specimen 15.5 inches long caught in Second Connecticut Lake, September, 1904.

A specimen 11.25 inches long caught at the same time, also a male, has a longer head, larger eye, longer snout, and somewhat longer fins. The color often varies from very dark, almost black, with dull yellowish or soiled white spots, to bright silver with more sharply defined, cleaner spots of white, gray, or yellow.

Other individuals vary somewhat from the above descriptions according to age, sex, breeding condition, and the water in which they occur.

Distinguished from all other trout or salmon by its color and sharply forked tail.

The lake trout is known most commonly in this region by the name of "laker" or "lunge." In Maine it is frequently called "togue" and in parts of New Brunswick "tuladi," and erroneously in other

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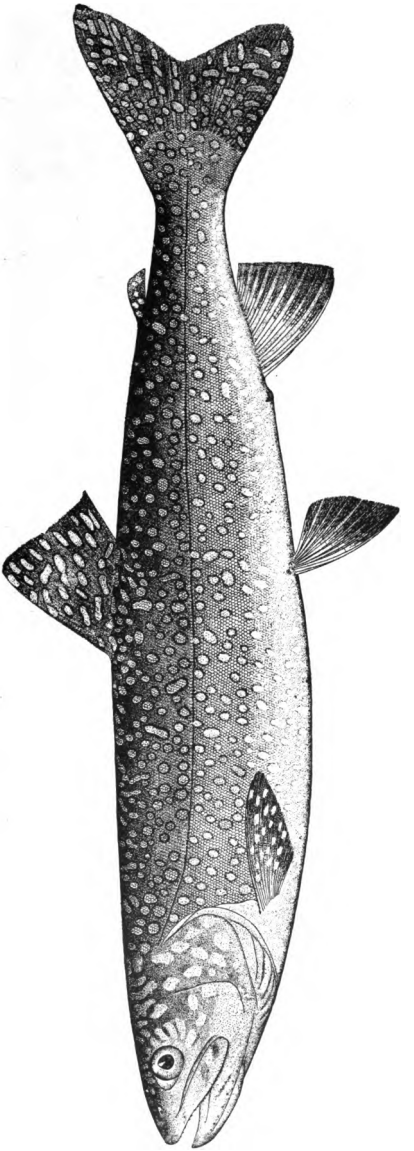

LAKE TROUT (*Cristivomer namaycush*).

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places salmon trout. In the Great Lakes it is "namaycush," "Mackinaw trout," etc. As "Mackinaw trout" it has been introduced into the Connecticut Lakes, although the same species was indigenous to those waters.

The lake trout is common over the northern part of the United States as far west as Lake Superior and extends northward to the Arctic regions. It occurs also in the Columbia and Frazer rivers and on Vancouver Island, but in very limited numbers. In the Report of the Fish and Game Commissioner of New Hampshire for 1892, page 77, it is stated "that this excellent food and game fish [*Salvelinus namaycush*] is indigenous to only six of our lakes, viz, First and Second Connecticut lakes, Squam Lake, Winnepesaukee Lake, including Winnisquam Bay, New Found Lake, and East Pond in Enfield." No adults were secured in First Lake, but in Second Lake some were taken.

This fish is a frequenter of deep water, especially in the summer time, approaching the shore or shoals at times for food, and in the fall for spawning. It is a voracious feeder when it feeds, but like other members of the salmon family it has its caprices, or at least, periods when it will not take a hook. It eats small fishes of almost any kind. Its spawning time is in September and October. Bean says (op. cit.) a female of 24 pounds carries about 14,943 eggs, but not over 5,000 and 6,000 as commonly found, and after the trout has attained maturity at 3 years of age, 1,000 eggs to the pound of fish may be accepted as a general rule. The eggs do not hatch until spring, when the waters begin to warm.

As a game fish it is not remarkable and it is inferior as a food fish. Opinions and tastes differ, however, regarding these qualities. The usual method of capture is by trolling in early summer, at other times by still fishing with live or cut bait. Cut chub is considered a good bait, and sometimes these morsels will be taken in preference to a whole minnow or shiner. The lake trout seldom takes a hook between the last of June and first of September. This habit of refraining from gratifying the angler or fisherman in summer while the water is above a certain temperature, the degree of which is not definitely known, is common to other members of the salmon family.

The records of the introduction of this fish into Connecticut Lakes, under the names of lake trout and Mackinaw trout, are as follows:

1893	100,000	1898	8,000
1894	25,000	1903	25,000
1895	100,000	1904	25,000
1896	80,000		

Young of this species, which may be some of those recently planted, or perhaps naturally hatched, were found in small tributary brooks of First Lake as follows:

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July 16: In a spring rivulet tributary of main inlet not far above its mouth, several were caught, 2 of which, 2.37 and 2.08 inches long, respectively, were saved. Their stomachs contained blackfly larvæ, insect fragments, and insect eggs.

July 18: In the same rivulet another specimen 2.08 inches long was taken. Its stomach was empty.

August 10: In Alder Brook, directly tributary to the lake, 4 were caught, measuring 2.08, 2.06, 2, and 1.87 inches long, respectively. Their stomachs contained blackfly larvæ, insects (head and wings), and mosquitoes.

18. Trout. *Salvelinus fontinalis* (Mitchill).

Plate xii.

The trout is so well known and varies so much in structure, shape, and color, that a detailed description is hardly necessary. But for comparison with the small brown trout a brief outline of the distinctive characters is given, drawn from a male specimen, collected at the same time and place as the brown trout. It is a typical "brook trout," 6.66 inches long.

Head 4.42 in length without caudal; depth 3.42; eye 5.25 in head; snout 4.20; maxillary bone 1.9; branchiostegals 10 on right side and 11 on left; gillrakers very short and rather stout, 6+10 on each side; dorsal 9; anal 8; scales about 225. Head bluntly conic, mouth rather large, distance from tip of snout to posterior extremity of maxillary 1.61 in head; mandible 1.44; eye moderate, distance between the eyes rather broad, 3.23 in head; body rather slender, slightly compressed; lateral line with about 118 pores; caudal peduncle rather deep and compressed; dorsal moderate, when depressed the tips of first rays not nearly reaching tips of last, 2.25 in head; base 2.1; anal falcate, the first rays longest, 1.61 in head, when depressed reaching far beyond the tip of last rays, base 2.62 in head; pectoral moderate, 1.68 in head; ventral 1.9.

Head and body to some distance below lateral line brownish olive; vermiculated on top of head and back with yellowish markings; sides iridescent, bluish and green, with large yellow spots and some smaller red spots surrounded with pale blue aureola; lower jaw creamy white; throat and branchiostegals dusky; belly much punctulated with dusky, causing an irregular clouding, conforming somewhat to the dark parr marks, 7 of which cross the sides; lower three-fourths of dorsal with large black spots arranged in irregular rows, sometimes coalescing, giving, with the lighter ground color, a vermiculated appearance to the latter; upper margin of fin straw with indistinct spots; pectoral, ventral, and anal orange, with first ray white, bordered by black within: adipose dusky, tipped with yellow; caudal orange and olive, finely barred with wavy marking.

This fish is very generally known as "trout." Sometimes to distinguish it from the laker it is designated as "squaretail," and from black-spotted fish of the salmon family as "redspot." It is also called "brook trout," especially when occurring in brooks. "Speckled beauty" is a pet name almost too hackneyed for repetition here, and "speckled trout" is not distinctive.

This trout is indigenous to most suitable waters from Nova Scotia to Labrador, throughout New England, northern New York, and the Great Lakes region, west to the Saskatchewan, ar[illegible]

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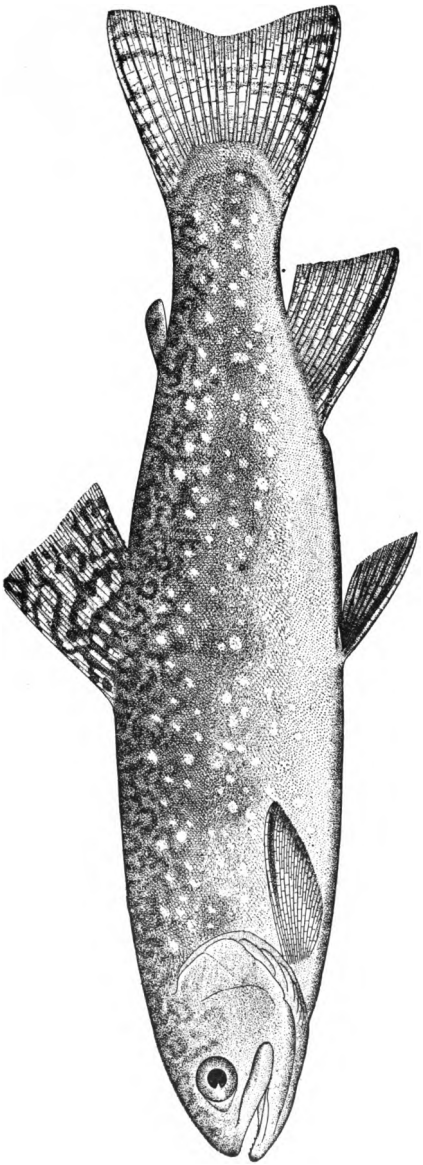

TROUT (*Salvelinus fontinalis*).

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tains south to Georgia. It occurs to some extent in all the waters of the Connecticut Lake region that were examined. It is not common in First Lake, but is more numerous in Second and plentiful in Third Lake. Every stream and pond in the region contains more or less trout, varying in size according to the body of water and in number according to the accessibility and ease with which the water is fished. Many of the little mountain brooks literally teem with small trout, frequently too small to be legally caught, yet some of them are adult fish and probably will attain no larger size. Small brooks, of whatever character, from mountain rivulets to sluggish bog brooks, seem to contain trout. Hundreds of these trout are caught every year, and it is a question whether any harm is done thereby, for while a few may reach the lakes or river and become large fish, most of them remain in the brooks, reach maturity, and spawn while still small fish.

There is an unaccountable scarcity of trout in First Lake. Apparently the food supply, depth, and coolness of water are well suited to the fish. The small tributary brooks contain some trout, and some are caught at the proper season every year in Main Inlet. It is possible that the lake has not recovered from an early excessive destruction of fish. No facts could be elicited regarding the capture of fish in previous years in these waters by net or night line, or by spear or net on the spawning grounds, but that there was more or less of such fishing is certain.

Round Pond contains trout in considerable numbers, up to 1 or 1.5 pounds in weight at least, but they are not always to be had at the asking or fishing. Even Mud Pond, so palpably unsuited to the fish, is inhabited by some, and Unknown Pond yields large fish, up to 4 or 5 pounds it is said, but they are hard to catch, owing to the shallowness and the clearness of the water.

Second Lake has more trout, some of which are of good size; 3 or 4 pounds is not the limit in weight. Many trout are caught in East Inlet, especially above the dam. At times during the season fine large trout are caught just outside or within the mouth of Main Inlet. Smaller trout occur in fair numbers all along the inlet to Third Lake. The other inlets to Second Lake at times contain some trout and occasionally good fishing is found just off their mouths in the lake.

Third Lake is the best of all. Trout are numerous, of excellent size for the table, and gamy enough to satisfy the most fastidious. Their activity in the water and delectability on the table compensate for any deficiency in size. There are some large trout in Perry Stream, but fewer in Indian Stream. Toward the heads of both streams trout are more numerous and smaller than farther down.

Some of the habits of the trout are well known, but its caprices are little understood. In this respect it is too much individualized to

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permit of much generalization. The habits necessarily vary with the habitat, also with the size of the fish. It may be said, however, that by nature the trout is a denizen of cool water. It is carnivorous and almost omnivorous within carnous limits, levying upon nearly every class of animal, worms, mollusks, crustaceans, insects, batrachians, fishes, birds, and mammals. It will eat its own eggs and young as well as those of other fishes. We have never known a trout to eat a frog or a tadpole, but have found in its stomach the next thing to it, the common water-newt (*Diemyctelus viridescens*), and have caught trout with a land-newt (*Plethodon erythronotus*) as bait. The main food supply of young trout is insect larvæ, insects, and other small invertebrates; a list of the insects and other things that have been found in trouts' stomachs would "fill a book." But the trout does not feed at all times. In most waters its feeding times are usually morning and early evening; apparently it does not feed much, if any, during warm sunny days, but if at all on such days, in the cool of the evening. It is probable, as is indicated by its behavior toward anglers, that it does not feed at all in warm bodies of water during the latter part of the summer. It ceases to bite at the advent of warm weather and begins to bite again on the first cool days of autumn.

The following notes present some of the more important observations upon the food of the trout of these waters:

June 30, Second Lake: One trout 12 inches long contained a number of chub minnows (*Couesius plumbeus*).

July 6 and 7, Mud Pond Brook near First Lake: A trout 6 inches long had in its stomach a blob (*Cottus gracilis*) 2.5 inches long, a dragon-fly larva, and a worm; still another had been feeding upon insects and insect eggs.

July 21, in small spring inlet of Mud Pond: Five trout, 6.04 to 6.91 inches long, contained flies, caddis larvæ in cases, and fragments of other insects, and 2 contained 4 and 5 seeds of the yellow pond lily, respectively, and some algæ and confervæ.

August 18, Third Lake: Trout measuring from 10.75 to 13.25 inches long had most of them been feeding upon some fine stuff with which the water this day was thickly permeated. It was a minute living organism the nature of which could not be determined. That the trout were feeding upon this may account for the fact that no trout were caught until evening. One contained a piece of backbone of some small fish, another had fragments of insects.

August 29, Second Lake: A 14-inch trout contained a partly digested chub minnow.

The only intestinal parasites observed were in a small trout from Mud Pond Brook near First Lake which contained a thread worm (nemertean) and in a 13.25-inch trout at Third Lake which was full of tapeworms (*Bothriocephalus*).

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The breeding time of the trout varies somewhat with the locality and climate, and temperature of the water in which it lives. The spawning season may be from the last part of September to December. In this region it probably varies also with the particular locality, whether small pond or brook, lake or stream. Although we made no observations in this direction, fish examined indicate that they would probably spawn in October. As is well known, trout spawn in shallow water on fine gravel beds in which they make a small hollow as a nest. The spawning beds may be a shoal in the lake or in some stream which the fish ascends for the purpose. The eggs are not all emitted at one time, but a female trout, usually attended by one and the same male, occupies the nest for several days. The eggs do not hatch until the following spring. The sexes differ much in appearance at this time, especially in large fish. The head of the male is longer, the lower jaw sometimes hooked, the mouth and teeth larger, and the coloration is more brilliant, the belly and some of the fins often being a brilliant red. The body of the male, too, has a thick coat of mucus, almost or quite obscuring the scales.

Under favorable conditions trout grow rapidly, but there is no way of answering definitely the frequent interrogation, How long does it take a trout to grow? According to circumstances a trout may attain in 2 years only 3 or 4 inches in length, or it may attain 10 or more inches. Under certain conditions, as in circumscribed localities like a small brook, trout often reach maturity when only 4 or 5 inches long and still bearing the marks of young fish. Again, mature trout have been seen of not over 5 or 6 inches in length in which these marks of youth had nearly or quite disappeared, and the male fish was a facsimile of its larger brother of the lake. We have also seen in lakes of considerable size trout 9 and 10 inches long still immature.

The food and game qualities of this fish are so well known to most residents and tourists in northern New England that it is unnecessary to say much on these points. Trout vary in these respects in different waters and also, of course, with the age of the fish. Trout 9 or 10 inches long with pink flesh, from a cool stream or lake, of which the previously mentioned Third Lake trout are examples, come very near to being the proverbial "dish fit for a king." The cause of the pink or reddish flesh of the trout is a much-discussed question which has not, so far as we are aware, been scientifically investigated. But we believe that the food of the fish has nothing further to do with it than its fattening effect on the fish. It is the fat in the tissues of the trout that is thus colored, and the plumper and fatter the fish, the more highly colored is its flesh. It is the flavor of the fat that gives the peculiar delicious flavor to trout so colored. A white-meated trout may be plump, but it is of leaner flesh and lacks the flavor of the other. Small trout in cold spring or mountain

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brooks are usually white-meated. Food is scarce in such places. Trout otherwise red-meated lose at the spawning time the red or pink tint to the flesh and also the good flavor. The fat is utilized in the physiological process of reproduction.

The game qualities of the fish are not always commensurate with its size and are sometimes apparently in inverse ratio; the larger the trout, the less gamy. Large trout are more powerful, pull harder, perhaps, and do a vast amount of rushing about, but the rushes are short and the pulling dogged. Small trout are more dashy, and far more active, often leaping from the water and taking the fly on their downward course. Notwithstanding this, most anglers will prefer the big fellow that is going to break the record.

The variety of the food of the trout suggests that the lures may be legion, and so they are. When trout are ravenous, as they sometimes appear to be, they will take almost any lure. These occasions are proverbially when the moon is in the right phase and the wind from the proper quarter; trout are too often capricious regarding lures, sometimes taking only natural bait, and that of certain kinds, sometimes accepting only certain artificial flies, sometimes taking troll or bait only in the spring, fly in early summer, accepting nothing for a following period, then taking fly again, or bait. The habits along these lines are many and variable. One rule or set of rules will hardly suit any two bodies of water.

In 1899 100,000 trout fry were delivered at Pittsburg, and in 1903 20,000 more were sent there, all of which were presumably planted somewhere in Connecticut Lakes.

19. Smelt. *Osmerus mordax* (Mitchill).

Head 4.24 in length without caudal; depth 5.8; eye 4.16 in head; snout 4.16; maxillary bone 2.77; dorsal 10; anal 16; scales 66–11.

Head rather pointed; mouth large, with sharp teeth on jaws, tongue, vomer, and palatines; distance from tip of snout to posterior extremity of maxillary 2.22 in head; lower jaw projecting, mandible 1.92 in head; eye large, gill-rakers slender, 12+22 in right side, 12+23 on left, the longest 1.5 in eye; body moderately deep, slightly compressed; lateral line incomplete, consisting of about 15 pores; pectoral slightly rounded at the tip, outer rays longest, 1.31 in head; ventral triangular, squarely truncate at posterior end, 8 rays; margin of dorsal straight, first rays longest, 1.47 in head, when depressed overlapping the last rays; adipose small and narrow; caudal forked; everywhere covered with white tubercles, conical except on sides of body, where they are elongate.

Top of head, snout, and front of lower jaw black; back light greenish, thickly punctulated with black; sides silvery, with few dots on margins of scales; cheeks and opercles thickly dotted; belly white, somewhat silvery, lateral stripe overlying an indefinite, dusky stripe composed of an aggregation of dark dots, most distinct posteriorly; dorsal transparent, finely dotted; caudal olive greenish, thickly dotted; pectoral pale with dotted outer rays; ventrals and anal plain or with very few dots.

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The above description is from a spent male 5.25 inches long from Massabesic Lake, New Hampshire, April, 1904. The identity of these smelts with the marine form is a question which must remain unsettled until a large series from many localities is studied; they are all provisionally called *Osmerus mordax*. And because there is so much variation in fresh-water smelts, especially in those from different localities, due chiefly to size, and also because it is likely that smelt, if existing at all in the Connecticut Lakes, are small, we give a description of a smaller individual, a spent male 4.37 inches long, selected from a lot collected in April, 1904, in Sunapee Lake, by Hon. Nathaniel Wentworth, chairman of New Hampshire Fish and Game Commission. The smelt was introduced into Sunapee Lake from Lake Winnepesaukee.

Head 5 in length without caudal; depth 8.09; eye 4.20 in head; snout 4.20; maxillary bone 2.62; dorsal 9; anal 14; scales 61–9. Head pointed; mouth large, with fine sharp teeth; lower jaw projecting; mandible 1.75 in head; distance from tip of snout to posterior extremity of maxillary 2.1 in head; gillrakers very slender, 12+22 on right side, and 12+23 on left, longest 1.42 in eye; body very slender; dorsal high, first rays longest, much longer than the base and much overlapping tips of last rays when depressed, 1.4 in head, base 2.62; pectoral long and pointed; caudal deeply forked, lower lobe the longer.

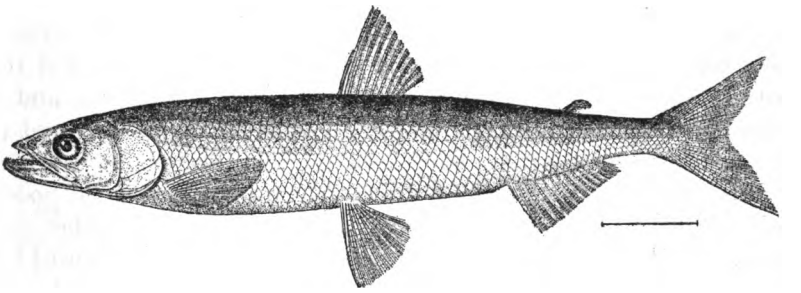

FIG. 5.—Smelt.

Top of head and back greenish, thickly punctulated with black, mostly on edges of scales; silvery on side below axis of body, with few black dots on edges of scales; ventral region plain white; dorsal transparent, finely dotted with black; caudal dusky from the many black dots; few dots on side of head, mandible, and throat; pectoral and ventrals pale, with few black dots on outer rays; anal pale with one black dot at base of each ray, a corresponding row on body at base of fin.

Distinguished from all other species of this region except those of the salmon family by the adipose fin; from all trouts, salmon and the laker, by the plainer coloration, and from the somewhat similarly colored "billfish" (and other whitefishes) by the large mouth and sharp teeth.

The smelt is universally known by this name and a few others. In Lake Champlain it is called the "icefish." Its salt-water range is from New Jersey north at least to the St. Lawrence River. The fresh-water smelt is thought to be the same species as the marine form, residing permanently, or landlocked, in fresh water. It occurs naturally in many coastwise lakes of Maine and New Hampshire and in lakes Champlain and Memphremagog but not in the Connecticut Lakes. It has been successfully introduced, however, into these and

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other fresh waters, where it has multiplied exceedingly. In fresh waters the smelt varies from a few inches in length to a much larger size than is usual in salt water. In some Maine lakes it has been caught weighing over three-fourths of a pound, and there are unauthentic reports of even larger ones.

In 1898, 100,000 smelt eggs were placed in First Connecticut Lake waters, but the results of the plant are uncertain. It is maintained by some that smelts are now so abundant as to furnish so great a food supply for salmon and lunge that they will not often take a hook, and that the few caught are gorged with smelts. Others state that in the spring large numbers of small fish have been seen in Main Inlet and still others have observed schools of smelts moving about the lake, sometimes undisturbed, at other times harassed by larger fish. We, ourselves, on a number of occasions saw the schools of supposed smelts, but were always unable to get near enough to identify them and could catch none by any means, until, by a device in the form of a small cork float and tiny gauze-winged artificial flies, which was cast among the supposed smelts in early evening, many bites were received. Only a few fish were hooked and these proved to be the gray chub-minnow (*Couesius plumbeus*) and the redfin (*Notropis cornutus*). These fish acted and maneuvered like schools of smelts that we had observed in other places when the identity of the fish was proved. So at these times it seemed possible that smelts had not bitten although present, while the other small fish accidently present had taken the fly. But one day in Third Connecticut Lake schools of fish were seen moving about almost everywhere at the surface of the water, acting identically as those of First Lake did and like the smelts first mentioned. Some of these were taken on tiny flies and were found to be *Couesius plumbeus*. There are no smelts in Third Lake. We have always found dead smelts at the surface and washed up on the shore occasionally in other waters under our observation where smelts existed, but no smelt was seen by us in these lakes. One well-informed resident and a well-known guide of this region at one time pointed out some attenuated chub-minnows and said that they were what were called smelts about here. They did look very much like smelts at first glance, but of course were easily distinguished. The guide's opinion may have been formed from having seen smelts and noting the resemblance in these fishes, so that he thought these were smelts, or it may be that these minnows are believed to be smelts. Under these circumstances we have some doubt about there being any smelts in First Connecticut Lake. The foregoing description will enable anyone to recognize the smelt should it be met with.

The smelt feeds upon small fishes and other small animals, and is a most ravenous little fish. It spawns in the spring, usually in

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streams it has entered for that purpose, but sometimes along shore among grass or in overflowed meadows. The breeding time begins in some places in the last of March, even before the ice is out of the lake; at other places it occurs in April and May. The majority of individuals first appearing on the spawning grounds are males, later the females appear. The eggs are small, numerous, and viscid, becoming attached to stones, plants, sticks, etc. It is recorded that a smelt weighing 2 ounces yielded from 46,000 to 50,000 eggs.

The smelt is an excellent pan fish, but it is difficult to get small ones except on the spawning grounds; however, in many waters where small ones occur there are large ones which may be caught on hook and line, in about 60 to 100 feet of water, by using pieces of fish or small minnows for bait on about a no. 1 or smaller sproat hook. The bite is feeble and sometimes will not be detected until one becomes accustomed to it.

20. Pickerel. *Esox reticulatus* Le Sueur.

Head 3.22 in length to base of caudal; depth 5.52; eye 10 in head; snout 2.16; maxillary bone 2.64; dorsal 13; anal 13; scales 128.

Head long, the snout long and depressed, without scales above, but cheeks and opercles entirely scaled; mouth very large, the distance from tip of snout to posterior extremity of maxillary 2.04 in head; lower jaw the longer, mandible 1.44 in head; premaxillary, vomer and palatines with broad bands of sharp strong teeth which are more or less movable; lower jaw with strong teeth of different sizes; tongue with band of small teeth; body elongate, somewhat depressed, broad anteriorly, compressed posteriorly; dorsal posterior, opposite and similar to anal, its height 2.53 in head; pectoral small, inserted low, 2.9 in head; ventrals rather posterior; caudal well forked.

Greenish with golden luster; belly yellow; side marked with reticulating dark lines and blotches; a dark band below eye, fins plain.

The above description is from a specimen 27.7 inches long weighing 4 pounds, caught in Matagamon River, Maine, August 25, 1902. The color varies much in specimens from different waters and of different sizes and ages. Smaller fish usually have the belly white rather than yellow. Young pickerel are cross-barred instead of reticulated and there is a light stripe along the median line of back from head to tail.

This species, which has been introduced in these waters, can be mistaken for no other fish in the region. From the pike it is easily told by the reticulated color markings. The pike has light spots or bars and only the upper half of the opercle is scaled. From the muskellunge it is distinguished by having the cheeks wholly scaled, and by the color marking, which in the muskellunge consists of dark unreticulated spots and short bars.

The pickerel is very generally known by this name, although in some other parts of its range it has other names such as "grass pike" and "jack." It has a pretty wide distribution in the Eastern States, but does not occur much west of the Mississippi River. Its recorded range, according to Jordan and Evermann, is Maine to Florida and Louisiana, Arkansas and Tennessee. The only locality in this region

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known to us in which the pickerel occurs is in Back Lake, a tributary of the Connecticut River.

The pickerel in some waters attains a weight of 7 pounds, but its average weight is much smaller; probably 2 or 3 pounds would be the average weight of the general run of large ones.

The habits of the pickerel are in most respects similar to those of other members of the family, the pike and the muskellunge. It has an unenviable reputation for fierce voracity and destructiveness. In many places it is despised and is almost universally anathematized by anglers and fishculturists. There is scarcely a body of water in which trout once lived and where pickerel now occur that the depletion of the trout has not been ascribed to the pickerel. In many instances the fish has undoubtedly been unjustly maligned. It is true that it will eat other fish if it can get them—there are few fish that will not do this. The highly esteemed and much-lauded trout and salmon are of the same sort, and the lunge rather than the pickerel should have the appellation of "fresh-water shark." During most of the year the pickerel resorts to waters uncongenial to trout, and at all times it prefers such waters. A warm, muddy pond or stream with profuse growth of aquatic vegetation is its favorite abode; trout can not exist long in such surroundings. In weedy waters where trout manage to exist, pickerel also will thrive, but trout will lie in the cooler, clearer portions while pickerel seek the water plants and shallow water. In most instances it would seem that the pickerel is not the whole, though possibly an accessory cause, of the disappearance of trout, and that the harm done by the pickerel is overestimated. The injurious effect of pickerel upon trout and salmon is more often indirect than direct, especially when it appears in congenial waters where trout or salmon are barely maintaining themselves or are decreasing. The indirect influence is upon the food supply, and this reverts upon the pickerel itself ultimately. It is an almost invariable rule that pickerel in time, after a period of increase in number and size, begin to decrease, owing to a diminution of the food supply. The pickerel is a very desirable and worthy game fish in suitable waters, but for reasons already given its indiscriminate distribution is not advised. It eats, and in eating deprives other and better fish of food; a harmony or balance of natural conditions might by this means be upset. The same may be said of any introduced fish.

The food of the pickerel is fish and other small aquatic animals. The young feed upon insects and the aquatic larvæ of insects. It spawns in the spring and early summer, but we are unacquainted with its spawning habits.

As a game fish the pickerel is highly esteemed by many. It will not always bite, the most attractive lure being often regarded with contempt and immobility. Then, again, it will voraciously strike at

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anything offered it. When hooked it seldom leaps from the water like a bass or salmon, but fights vigorously and rushes and tears about until, wearied with the struggle, it yields to the landing net or gaff.

There are many methods of fishing for the pickerel. It is trolled for successfully with any of the various artificial baits, such as phantoms, spoons, and spinners, which may be used with or without bait. Casting and "skittering" is perhaps the favorite method with sportsmen, who use a long rod or pole and casting spoon or fish or frog bait. In this method the bait may be made a whole shiner or a strip from the white belly of any fish; a whole small frog, or the skinned leg of a large one, or at times a piece of pork, red flannel, or white cloth, when nothing better is available. In fishing with artificial lures of any kind the pickerel should be struck the instant it bites; with natural bait the line should be slackened and the fish should be allowed to retain the bait until it has swallowed it or got it well into the mouth, as it usually takes the bait crosswise, then stops and works it round endwise to swallow it, and does not get the hook into its mouth until it has begun to swallow the bait.

Still-fishing with live shiner or frog is another method suitable to anglers with less strenuous dispositions. In still-fishing the shiner should be hooked through the back just in front of the back fin with the front of the hook toward the head, with care not to injure the spine of the fish. A frog should be hooked through the tip of the lower jaw and nose. Fishing through the ice with set lines and hand lines is a common pastime or occupation in many localities. The set lines are used with a "tip-up" flag showing when there is a bite. Hand-line fishing in winter is much the same as still-fishing in summer.

As a food fish the pickerel is held in esteem by many and disliked by a few. The chief objection to it is its boniness.

21. Blob. *Cottus gracilis* Heckel.

Head 3.3; depth 6; snout 3.5; eye 4; dorsal VII, 17; anal I, 10. Body slender, not compressed; head large, snout short, wide and blunt, its profile straight and rather steep from eyes to tip; mouth wide, nearly horizontal, no teeth on palatines; maxillary reaching anterior edge of orbit; eyes high; preopercular spine small, concealed, nearly straight or slightly curved upward.

Origin of spinous dorsal slightly posterior to upper base of pectoral, small, less than half height of soft dorsal and not joined to it; soft dorsal long and high, longer and higher than anal; caudal rounded; tips of ventrals not quite reaching vent; pectoral longer, reaching anterior base of anal.

Color in life, in some examples dark brownish gray, the bands almost black; others much lighter; edge of first dorsal tipped with reddish orange; lower part of 3 or 4 posterior spines dark, making a dark oblong spot, the first 1 or 2 spines also darkish for lower half of their length; anterior part of second dorsal rays each with a mottled orange appearance, though not so evident as the orange

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of first fin; pectoral mottled brownish, blackish toward base, the brown entirely on rays and not on membrane. These markings evident only in the larger examples (about 3 inches), the smaller ones having all the fins nearly transparent; a slight brownish and darkish mottling sometimes showing at base or lower half of pectoral and similar marking on soft dorsal. Most of the examples show 5 or 6 dark marbled cross-bands on body, though these vary greatly and are not alike in any two examples; head marbled with narrow streaks of brown or grayish brown, this extending posteriorly sometimes the entire length of body, the bands being darker than this marbling. The colors vary greatly, no two specimens being exactly alike.

Of 10 specimens from Mud Pond Brook, ranging in length from 2.37 to 2.87 inches, the head in length to base of caudal ranges from 3.22 to 4.13, average 3.42; eye in head 3.22 to 4.50, average 3.81; length of pectoral 0.95 to 1.28, average 1.12; dorsal VII or VIII, 16 to 20; anal 10 or 11.

Distinguished from the cusk by its broader head and pectoral fins and the presence of a small spine on the gill-cover (preopercle) and the absence of barbel at tip of lower jaw.

The names of the fish are mainly characteristic of its appearance, and "millers-thumb" and "star-gazer" are obviously appropriate. It is sometimes called "brook cusk" or "rock cusk" from fancied resemblance to the cusk. It is, however, not a cusk, but a fresh-water representative of the sculpins of salt water. A good name for it would be fresh-water sculpin.

Its recorded range is streams of New England and New York, tributaries of the Connecticut, Lake Champlain, Hudson, Delaware, and Susquehanna rivers.

In some waters this species attains a length of several inches, but the majority of the individuals are small, though somewhat larger than those collected in First Lake.

It feeds mostly upon insects, insect larvæ, and other small aquatic animals, and has been accused of eating fish ova and newly hatched young. The stomachs of some collected in Mud Pond Brook, July 12, contained insect larvæ, mostly of the black fly. The blob is itself sometimes eaten by other fishes, and might make a useful bait.

The easiest method of catching it is by means of a wire minnow trap.

22. Burbot. *Lota maculosa* (Le Sueur).

Head 4.03 in length without tail; eye 9.54 in head, snout 4.06; dorsal 14-74; anal 71; scales 240.

Head depressed, rather broad; anterior nostrils each with a small barbel; chin with a long barbel; snout and lower parts of head naked; mouth moderate, the distance from tip of snout to posterior extremity of maxillary 2.23 in head; lower jaw included, mandible 2.01 in head; each jaw with broad bands of equal villiform teeth; vomer with a broad crescent-shaped band of teeth; no teeth on palatines; gill-openings wide and connected, but free from isthmus; branchiostegals 8 on right side and 7 on left; gillrakers short 1+7 on right side and 1+8 on left. Body long and low, somewhat depressed in front, com-

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pressed behind; scales very small and somewhat imbedded; dorsals 2, the first short, the other long; one long anal; pectoral comparatively short, 1.72 in head; ventrals ending in filaments, 1.69 in head; caudal rounded.

General color of head and body above and on sides greenish-yellow, mottled and spotted with very dark brown; belly soiled white; dorsals, anal, pectoral, and caudal same color as body; ventrals soiled yellowish; under parts of head soiled white; some yellow on branchiostegals; iris light orange.

Description from a male specimen 18.25 inches long caught on trawl with cut chub bait in about 30 feet of water.

The burbot varies considerably in proportions and color, both individually and locally. In color some are very much more mottled and blotched and with more or less definite black spots. In 12 specimens from First and Second Connecticut lakes, ranging from 10.12 to 19.12 inches in length, and averaging about 15, the length of head in length of fish to base of caudal varies from 3.46 to 4.64, average about 4.22; the longest diameter of eye in length of head 7.28 to 9.54, average 8.25; snout 2.22 to 4.11, average 3.39; maxillary 2.12 to 2.67, average 2.29; mandible 1.61 to 2.54, average 1.94; pectoral 1.50 to 1.89, average 1.74; ventral 1.5 to 2.02, average 1.82. Jordan and Evermann give the gillrakers as about 3+6. In most of our examples the number on the short arm was 1; in one instance only were there 2; the number on the long arm varied from 6 to 9, sometimes differing by one on the 2 sides of the same individual. The branchiostegals were seldom the same on both sides of the same specimen, running 8–7, 7–6, 7–7, 7–5. The scales reached as high as 262. The number of pyloric cœca, as given by Jordan and Evermann, is 30. Bean says from 30 to 138. In our specimens the arrangement is irregular and hard to count. There were several main roots, some of which had as many as 5 subdivisions and these were again divided into 2. One specimen had 11 main clusters and 46 smaller subdivisions. In our counts we have taken the individual points; they range in number from 49 to 90. Of 11 specimens 6 were females and 5 males.

This fish is distinguished by its shape and the barbels on nostrils and at chin and can not be confounded with any other species found in this region.

"Cusk," "fresh-water cusk," "ling," "lawyer," "losh," "eelpout," etc., are a few of the many names by which this fish is known, but "burbot" is preferable. In some parts of Europe it is called "tadpole."

Wherever it occurs it is usually rather abundant, although some lakes in New England, where this fish is esteemed, are somewhat depleted. The burbot has a very wide range, extending through the northern states to the Fraser River, the Arctic regions, and Alaska. It has been reported from as far south as Kansas, although none has been found south of New York on the Atlantic slope. Most deep lakes in New England contain the "cusk." It occurs in all three of the Connecticut lakes, and small ones have been taken in tributary and neighboring waters. It seems to be common in this region.

In Maine and New Hampshire it is usually considered a good food fish, but in the Great Lakes region the fishermen despise it. Probably this is because so many are caught in fishing for more desirable species. We, personally, prefer it to the "laker." It makes an excellent chowder and is very good when cooked in other ways. In these waters it probably does not attain a weight of over 4 or 5

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pounds, but in other places it is known to reach 8 or 10 pounds. In Alaska some are said to have been caught weighing 60 pounds.

The burbot affects rather deep water, approaching the shore at night to feed. It subsists to a great extent upon other fishes, their eggs and young. Very little is known of its breeding habits and life history. It probably spawns about February or March on the gravel bottoms of lakes and streams. Young from 1.9 to 2.45 inches long were taken in pools in a field on Indian Stream. We are unable to ascertain that young so small as these have been observed before. They were very delicate, died quickly, and became distorted about the head, although the water in the minnow bucket, in which minnows lived very well, was changed frequently. Their appearance was much like the adult, and easily recognized. The color was somewhat mottled olive, tip of first dorsal reddish.

Young from 2.75 to 6 inches in length were taken in East Inlet of Second Lake. The stomachs and intestines of these young fish contained a variety of things, consisting partly of fragments of insects, shells of entomostraca, mites, and larval insects, principally the black fly.

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THE PLANKTON ENVIRONMENT IN THE CONNECTICUT LAKES.

By A. A. Doolittle.

The present chapter records observations made at the headwaters of the Connecticut River, in the Connecticut Lakes, upon the environment of their minute suspended animal and vegetable organisms. The exhaustive determination of all the plankton forms collected and the study of them as to quantity, life cycle, distribution, and reaction to environment must be continued and reported upon later.[a]

FIRST LAKE.

The water of First Lake was examined thoroughly during the summer of 1904 for its plankton elements, and samples were taken from the Second and Third lakes and tributary streams and ponds as opportunity offered. At First Lake during the unfrozen season the prevailing winds are from the south and west, and where they have a long sweep they have piled up beaches of sand or gravel. The open space is so great that waves of considerable power are made, sufficient, at least, to prevent the establishment of any plants in the shallow bottoms off these shores, and the formation of a harbor for littoral forms of plankton. Two places on the northern shore are, however, protected, partly by points of land and partly by a very gradually shelving bottom, so that some aquatic vegetation has become established. All the shores protected from the west or south support water plants, and those protected from both directions much more. The other shores present too broad a belt of sand or barren

[a] Assistance in the determination of the aquatic species is gratefully acknowledged as follows:

Bryophyta.—Mr. E. B. Chamberlain, of New York City.

Angiospermæ.—Mr. E. L. Morris, Brooklyn Institute Museum, Brooklyn.

Infusoria.—Dr. Geo. T. Moore, Chester, Pa.

Hirudinea.—Dr. J. Percy Moore, University of Pennsylvania.

Insecta.—Dr. A. E. Schwarz and Dr. D. W. Coquillet, and Mr. H. S. Barber and Miss Evelyn G. Mitchell of the National Museum.

Mollusca.—Dr. Paul Bartsch, Smithsonian Institution.

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rocks to support much vegetation. The line of fertile soil is too far removed from the water to support the water-loving shrubs which fringe the other ponds and lakes of the neighborhood. The vegetation of the muddy shores is a heavy growth of grasses, sedges, and rushes, whose identification has not been completed at this writing.

Fixed aquatic vegetation.—The following species of plants were found established in the waters of the First Lake. Those marked with an asterisk were seen only in waters immediately adjoining. The distribution of the plants in the lake will appear in the description of the stations at which plankton was collected.

AQUATIC PLANTS FOUND ESTABLISHED IN FIRST LAKE.

Chara coronata Ziz.
Fontinalis antipyretica Linnæus.
dalicarica Bruch & Shimper.
Equisetum fluviatile Linnæus. Horsetail.
lævigatum A. Braun. Horsetail.
Sparganium androcladum fluctuans Morong. Bur-reed.
simplex Hudson. Bur-reed.
simplex angustifolium (Micheaux) Engelmann. Bur-reed.
Potamogeton amplifolius Tuckerman. Pond weed.
nuttallii Chamiss & Schlechtendall. Pond weed.
prælongus Wulfin. Pond weed.
pusillus Linnæus.
spirillus Tuckerman.
robbinsii Oakes.
Sagittaria latifolia Willdenow. Arrow-head.
graminea Micheaux.
Eleocharis acicularis (Linnæus) Roemer & Schultes. Needle rush.
**Calla palustris* Linnæus. Wild arum.
Nymphæa advena Solander. Yellow pond lily.
hybrida Peck. Red-disked pond lily.
Batrachium trichophyllum (Chaix) Bossch. White water crowfoot.
**Callitriche palustris* Linnæus.
Myriophyllum alterniflorum De Candolle. Water milfoil.
* *farwellii* Morong. Water milfoil.
**Utricularia vulgare* Linnæus. Bladderwort.

Quality of the water and source.—The water shows a very decided brownish tint, discernible in even so small a quantity as a tumblerful. The plankton net showed a surface 14 inches in diameter of soiled white color, which disappeared on the brightest days at a depth of 10 feet. The water was excellent in flavor. Tests carried out with as great care as possible showed it to be well aerated to considerable

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depths. The source is in the immediately surrounding timber-covered hills or mountains. The prevailing trees are black spruce (*Picea mariana*), yellow birch (*Betula lenta*), sugar or rock maple (*Acer saccharum*), and American beech (*Fagus americana*), with an undergrowth of speckled alder (*Alnus incana*) and other shrubs and herbs of northern New Hampshire. In the aggregate there is considerable sphagnum swamp in the drainage basin contiguous to this and the neighboring lakes. The water acquires its color, no doubt, during its slow seepage through the forest and marsh land by taking up considerable organic matter in solution.

Main Inlet.—The Main Inlet for a mile and a half before entering First Lake meanders through an extensive meadow, the upper part with appreciable current, but the lower half or three-fourths mile sluggishly, with much shallow water on each side of the channel and many lagoon-like bays indenting the shore. The depth varies from 4 feet in the channel to an inch or less on the muddy bars. The stream has its temperature lowered from some cause in the last mile of its course to the extent of 2° F. Vegetation is abundant, especially in the shallower portions. Bur-reed (*Sparganium simplex* and *S. simplex angustifolium*), pond weed (*Potamogeton amplifolius* and *P. nuttallii*), needle rush (*Eleocharis acicularis*), and the yellow pond lilies (*Nymphæa advena* and *N. hybrida*) predominate.

Temperature of the water.—The temperature of the sources of supply was during the summer season the same for all streams entering from wooded land, namely 55° F., or 13° or 14° lower than the surface temperature of the lake during the greater part of the season and equal to the temperature at a depth of about 25 feet. The Main Inlet at its entrance during the mid-season was 64° F., after being cooled by the addition of cool water through seepage. The water entering from near-by springs was colder, registering 50°. The temperature of all springs rising in the mountains registered 42° at their sources. Contact with the air soon raised their temperature to 55°.

The surface temperature of the lake water underwent a change of 10° during the period of observation. It was learned that the ice broke up and left the lake May 9, 1904; temperature 32° F. On June 28 the surface registered 66° F. The maximum temperature was registered on July 19 and 20—72.5° F., which fell by September 10 to 62° F. A fall of rain accompanied by wind usually caused a lowering of the surface temperature of 1½° to 2°. The original temperature was regained, however, in twelve to thirty-six hours during the warmest part of the season. In the latter part of the season the decline of surface temperature was by these sudden drops, from which there seemed to be no recovery. South Bay had a maximum temperature of 75° F. on July 19. This high temperature is

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probably due to the fact that the bay has almost no tributaries and is out of the direct currents entering and leaving the lake, while the prevailing winds drive no cooler water into the bay. Its temperature together with its greater amount of fixed aquatics would indiate a plankton of somewhat different character and quantity from the rest of the lake. Some of the shallower coves, exposed to the sun, registered as high as 80° F. on this same day. The surface temperature held with but slight lowering to a depth of 15 feet, but deeper in the later and colder part of the season. At 20 feet the temperature approximated 65° F. and at 30 feet 51° F. The thermocline lay at about 25 feet, but was not confined to a thin stratum of water. From day to day, and in different parts of the lake, the thermocline was found at different levels. The changes seem to be most closely related to the piling up of the warmer surface water under pressure of the wind and a somewhat tardy lowering of the thermocline in the lee portions of the lake. From the 30-foot level the water temperature decreased uniformly to a temperature of 46° F. at 60 feet, which was maintained practically to the maximum depth of 140 feet.

Temperature of air.—The temperature of the air shows a mean much below that of the surface of the water. The mean temperature of the air for July was 63.5° F., and for August 57° F., while the average of the surface temperature during these months was 68.4° F. and 67° F., respectively. The night temperatures show an average minimum of 18.7° F. below the average for the surface for the period from July 22 to September 1, and an average of the daily maxima 5.1° F. above the average surface temperature.

The prevailing winds were from the west and south, the former bringing fair weather and the latter clouds and rain. There was no protection in these directions, and the shape of the lake permitted a sweep of wind through one of the long axes at all times. The wind was as a rule very regular and brisk during the day, but quieting over night when from the west. The usual day breeze was 10 miles an hour. During the month of August a slight drift of wind came at night from the northeast, but it did not seem to affect the water appreciably.

The usual day breeze of 10 miles an hour caused waves to run 1 foot or more high and to form slight combs. From July 1 to September 1 the waves were rough, breaking into white caps on 24 days and continuing rough on 14 nights. Smooth water or waves of moderate height, not breaking into white caps, occurred during 38 days. On 28 nights the water was relatively smooth, and on 20 occasions the water became rough during the night. In the appended table of meteorological observations but three grades of agitation of surface are recorded. Under " smooth " are included all glassy sur-

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faces, whether rippled or not. Under "waves" are included all ruffled water not breaking into white caps. Under "rough" are included all crested waves. These grades of surface present clearly marked distinctions which some forms of plankton may recognize and to which they may react.

Adjacent pools.—On the east and north shores of the large eastern expanse of the lake the sand of the beach is piled up in such a way as to impound in several places the water which may wash over from the lake or find its way into the hollows by seepage or from springs. In one of these in the northeast curve of the lake and a similar one in the middle of the north shore line the supply from springs is sufficient to cause a constant stream to cut its way through the intervening bank and enter the lake. The conditions of life in these pools are very different from those found elsewhere. The shallow expanse, almost unchanging water, and resulting high temperature, 80° F., give a peculiar flora. The pools on the east differed from those on the north. The east pools were filled with *Mougeotia* sp., *Chara coronata*, *Potamogeton pusillus*, *Callitriche palustris*, *Myriophyllum alternifolium*, and *Utricularia vulgaris*. The pool on the north was filled with *Sagittaria latifolia*, *Myriophyllum farwellii*, and *Utricularia vulgaris*. This pool remained luxuriant throughout the season, while those on the east became choked with vegetation and cleared through decomposition during the summer. The pools which have communication with the lake doubtless are a source of plankton forms loving or requiring quiet water of relatively high temperature and a dense vegetable environment.

SECOND LAKE.

Shore vegetation.—The shore line of the northern part of this lake is of small bowlders along the western shore and the tongue of land. A small portion of the eastern shore which receives the sweep of wind across the entire lake is a sandy beach. The remainder of the shore line and the shore line of South Bay is a turf. The rocky shore is characterized by royal fern (*Osmunda regalis*), sweet gale (*Myrica gale*), speckled alder (*Alnus incana*), meadow-sweet (*Spiræa salicifolia*), red osier dogwood (*Cornus stolonifera*), rhodora (*Rhodora canadensis*), sheep-laurel (*Kalmia angustifolia*), and withe-rod (*Viburnum cassinoides*), with a background of black spruce (*Picea mariana*), fir balsam (*Abies balsamea*), paper birch (*Betula papyrifera*), and yellow birch (*B. lutea*), with a very occasional specimen of white pine (*Pinus strobus*). The turf shores were covered with the grasses and sedges common to the region.

Sources.—The visible sources of water are five streams, two of considerable size—the Main Inlet, or Connecticut River, at the northern end of West Cove and a small stream at the northwest curve of

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West Cove, East Inlet entering East Cove, and two small streams entering from the southeast.

The Main Inlet enters from the north after meandering for a distance of 1 mile or more through open country as a sluggish stream, 30 feet wide, and 2 to 3 feet deep. In the rapid water 1½ miles above the lake, the temperature registers 57° F.; in the lower stretches, out of reach of lake influence, the water registered 54° F. at a time when the surface of the lake was 62° F. The cooling of the water of the river, similar to that observed at the entrance of the Main Inlet to the First Connecticut Lake, is therefore to be noted. Considerable beds of chara (*Chara coronata*), bur-reed (*Sparganium simplex angustifolium*), pond weed (*Potamogeton amplifolius* and *P. nuttallii*), and milfoil (*Myriophyllum alterniflorum*) occupy the bottom, particularly toward the entrance to the lake.

The stream from the northwest meanders similarly from the hills in the distance. Its temperature was 56° F. on August 20. The East Inlet enters at the northeastern curve of the lake from the east. Its course can be traced through open country for 5 or 6 miles easterly with but few rapids among the hills which feed it. Its temperature is higher than the other inlets, due, no doubt, to its longer exposure to the sun in stretches of dead water. From the hills on the immediate east are two small streams, seeping their way to some degree through the intervening meadow.

Fixed aquatic vegetation.—The western shore is protected from the prevalent wind and consequent wave action. Here in the shallow protected water of the limnetic bench were established pond weed (*Potamogeton pusillus* and *P. spirillus*), needle rush (*Eleocharis acicularis*), pipewort (*Eriocaulon septangulare*), and water lobelia (*Lobelia dortmanna*). In East and West coves of the main portion of the lake and in South Bay were mixed beds of chara (*Chara coronata*), pond weed (*Potamogeton amplifolius*, *P. prælongus*, and *P. perfoliatus*), pond lilies (*Nymphæa advena* and *N. hybrida*), water milfoil (*Myriophyllum spicatum*), and *Batrachium trichophyllum*, all of which are plants able to root at depths below the limit of the wave action of this lake and to resist, when at the surface, some degree of roughness. The growth of these aquatics is greatest in South Bay, and only a little less dense in East Cove. In the shallower, more protected corners of the lake were occasional beds of pond weed (*Potamogeton nuttallii*), milfoil (*Myriophyllum alterniflorum*), and *Sagittaria graminea*, in addition to the omnipresent great yellow pond lily (*Nymphæa advena*). The quantity of fixed aquatic vegetation was greater in this lake than in any other of the larger bodies of water in this vicinity. The single detached specimen of *Potamogeton perfoliatus* apparently loosened in sounding or dredging indicate a flora possibly undiscovered.

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Character of the water.—The color of the water of Second Connecticut Lake was the brownish tint common to these lakes. Its temperature at the surface was 2°F. higher than that of the surface temperature of First Connecticut Lake at the same time. At the bottom depth of 65 feet 50° F. was registered as compared with 46° F. on bottom at the same depth in the First Connecticut Lake. Its higher temperature is easily accounted for by its relatively greater exposure to the sun.

The conditions of this lake seem to favor a greater amount of plankton, both animal and vegetable, than First Connecticut Lake supports. The higher temperature, the lesser depths, the greater amount of fixed aquatic vegetation, and the character of the inlets seem to favor littoral forms.

THIRD LAKE.

Shore vegetation.—The shores of this lake are covered with black spruce (*Picea mariana*) and yellow birch (*Betula lutea*), with a fringe of arbor vitæ (*Thuja occidentalis*) and a scattering of the other hard-wood trees of the region. Among these trees is an undergrowth of shrubs, among which are mountain holly (*Illicoides mucronata*), sheep laurel (*Kalmia angustifolia*), withe-rod (*Viburnum cassinoides*), and stag bush (*Viburnum prunifolium*). Along the border of quiet streams were banks of sweet gale (*Myrica gale*) and rhodora (*Rhodora canadensis*), and along wooded streams the ever-present speckled alder (*Alnus incana*). Ferns of great variety, mosses, and both leafy and thalloid liverworts covered the ground, mingling with a sparse turf. Vegetation came to the edge of the water. The shore line was therefore protected by roots and turf, except portions of the western shore, which were rocky. The bottom near shore formed a narrow limnetic shelf of sand, 20 feet wide and 3 feet deep at its outer edge. The further descent is sudden and ran to the general depth of 80 feet. A maximum depth of 103 feet was found.

Fixed aquatic vegetation.—On the limnetic bench were established the seven-angled pipewort (*Eriocaulon septangulare*), the needle rush (*Eleocharis acicularis*), and the water lobelia (*Lobelia dortmanna*), and on the sudden descent at the edge pond weed (*Potamogeton amplifolius* and *P. nuttallii*). There seemed to be no other fixed aquatic plants in the lake. The shallower, warmer waters of the inlet harbored aquatic plants not found in the lake itself—horsetail (*Equisetum lævigatum*) and bur reed (*Sparganium simplex angustifolium*), and there flourished here the great yellow pond lily (*Nymphæa advena*) as well as the species of *Potamogeton* found in the lake.

The temperature of the rapid water of the streams entering from the hills was uniformly 55° F. on August 15, 1904, the same as of

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similar brooks throughout the entire region. The temperature of the dead water of the main inlet rises to 65° F. near its entrance, almost to the temperature of the lake itself. The lake registered lower than any of the other bodies of water visited. On August 17, 1904, the temperatures were as follows:

Depth.	Temperature.
Feet.	°*F.*
0	66
5	66
10	66
20	65
30	52
40	45
a 103	43

a Bottom.

ROUND POND.

The shallow water of the edge of Round Pond is turfed with needle rush (*Eleocharis acicularis*), the seven-angled pipewort (*Eriocaulon septangulare*), and the white lobelia (*Lobelia dortmanna*). At places this turf yields to beds of *Panicularia fluitans* and *Eleocharis palustris*, or to rocks. In deeper water is established a bed of *Nymphæa advena.*

The height of the hills protects the lake effectually from winds and a long exposure to the sun. The temperature of the surface was that of First Connecticut Lake at the same time, due possibly to the broad shallow margin exposed to sun and air, but the temperature declined very rapidly with the depth as follows:

Depth.	Temperature.
Feet.	°*F.*
0	69
20	52
30	45
a 47	44

a Bottom.

The color of the water was brownish, but otherwise clear and of good flavor. On the whole this lake very closely resembled Third Connecticut Lake as a plankton environment.

LOCATION OF THE PLANKTON STATIONS.

First Lake.—Six permanent plankton stations were established and marked by buoys. Their positions are indicated by capital letters upon the accompanying map.

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A. Depth, 80 feet; was selected as typical of the open body of the lake, and always accessible.

B. Depth, 90 feet; near the influence of rocks.

C. Depth, 80 feet; was in touch with the shallow and warm water of the outlet.

D. Depth, 140 feet; was located in the deepest part of the lake.

E. Depth, 100 feet; was chosen to secure the plankton characteristic of the large and quiet body of water lying in South Bay.

F. Depth, 30 feet; was in the environment of a sandy shore, and to secure such plankton as the Main Inlet might be pouring into the lake.

Plankton was also taken from time to time from 21 special localities, indicated by Roman numerals on the map, distributed and characterized as follows:

I. The shallow marshy area at the mouth of Mud Pond Brook, characterized by *Sagittaria latifolia* and *S. graminea.*

II. At the mouth of shallow pool on north shore, which was fed by springs, and characterized by *Myriophyllum farwellii, Utricularia vulgaris,* and *Sagittaria latifolia,* to determine what plankton was supplied from this source.

III. Mouth of Round Pond Brook.

IV. Lower reach of Main Inlet. Vegetation of *Potamogeton amplifolius, P. nuttallii, Sparganium simplex angustifolium, Eleocharis acicularis, Nymphæa advena,* and *N. hybrida.*

V. Immediately off the mouth of Main Inlet.

VI. Surface tow of open lake.

VII. Surface tow of open lake.

VIII. Surface tow in West Bay.

IX. Thirty feet of water, near shallow cove of West Bay.

X. Shallow cove of West Bay, characterized by *Myriophyllum alterniflorum* and *Nymphæa advena.*

XI. Near outlet, over 30 feet of water.

XII. Protected waters of South Bay, 15 feet deep, among *Potamogeton pusillus, P. spirillus,* and *Myriophyllum alterniflorum.*

XIII. Protected waters of South Bay, 15 feet deep, characterized by *Myriophyllum alterniflorum.*

XIV. Protected water of East Bay, sparse growth of *Chara coronata.*

XIVa. Wave pool on east shore.

XV. Water of Round Pond Brook before entering First Lake.

XVI. Dead water of Main Inlet above the lake before it enters the region of vegetation.

XVII. Rapid water of the Main Inlet.

XVIII. Water of Alder Brook.

XIX. Water of lake off Alder Brook.

XX. Bed of *Potamogeton nuttallii* in West Bay.

XXI. Bed of *Potamogeton nuttallii* and *P. pusillus* in South Bay.

Second Lake:

(*a*) In East Cove, depth 15 feet, among *Chara coronata, Potamogeton amplifolius, P. prælongus, P. spirillus, Nymphæa advena, N. hybrida, Myriophyllum spicatum.*

(*b*) In rapid water of inlet.

(*c*) Still water of inlet in beds of *Chara coronata, Potamogeton amplifolius, P. nuttallii, Batrachium trichophyllum.*

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(*d*) Various protected coves among *Sparganium simplex*, *Sparganium simplex angustifolium*, *Sagittaria latifolia*, *S. graminea*, *Eriocaulon septangulare*, *Nymphæa advena*, and *Lobelia dortmanna*.

(*e*) At various levels to the maximum depth of 65 feet.

(*f*) South Bay, depth 15 feet, in various places among same vegetation as *a* supra.

(*g*) Outlet, to see what plankton was leaving the lake.

(*h*) East Inlet, in both dead and rapid water.

Third Lake:

(*a*) On the limnetic bench, depth 2 feet, over *Eriocaulon septangulare* and *Lobelia dortmanna*.

(*b*) At various levels to maximum depth of 103 feet.

(*c*) Inlet among *Potamogeton amplifolius*, *P. nuttallii*, *Nymphæa advena*.

(*d*) Outlet, for the escaping plankton.

Round Pond:

(*a*) On the limnetic bench in 2 feet of water, over *Eriocaulon septangulare* and *Lobelia dortmanna*.

(*b*) At various levels to maximum depth of 47 feet.

(*c*) At outlet for the escaping plankton.

MACROSCOPIC FAUNA OTHER THAN FISHES.

Some aquatic or semiaquatic animals other than those belonging to the plankton came under observation as the headwaters of the Connecticut River were examined. A thorough search would multiply many times the number of species found. The following list enumerates all the species noted, but it does not attempt to give their complete distribution in these waters.

Infusorians.—*Ophrydium* sp. Quiet, warm waters of First and Second lakes.

Sponges.—*Spongilla* sp. Abundant in the shallow quiet water of inlets and pools of First, Second, and Third lakes.

Bryozoans.—*Cristatella magnifica*. Taken from rocks along shore of First Lake.

Leeches—

Dina fervida Verrill.

Glossyphonia complanata Linnæus.

Placobdella picta Verrill.

Crustaceans.—The only crustacean observed was living among sponges, an amphipod, specimen lost.

Insects—

Phryganidæ, various species, including *Helicopsyche* sp. Larvæ taken from shore rocks of First Lake.

Bittacomorpha clavipes Fabricius. Larvæ dredged in Second Lake with *Chara* and *Batrachium*.

Chironomus sp. Tubes containing larvæ and pupæ common on *Chara* and *Batrachium* in Second Lake.

Tanybus sp. Tubes containing larvæ and pupæ common on *Chara* and *Batrachium* in Second Lake.

Dryops sp. Abundant on shore rocks of Second Lake.

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Mollusks—

Pelecypods—

Strophytus edentulus Say.

Anodonta cataracta Say.

Alasmidonta undulata Say.

Margaritana margaritifera L. Perry Stream and Connecticut River.

Gastropods—

Physa heterostropha Say. The Connecticut Lakes.

Planorbis bicarinata Say. The Connecticut Lakes.

Amnicola orita Say. The Connecticut Lakes.

Polygyra albolabris Say. Forests.

Batrachians—

Spelepes bilineatus Green. In small tributaries of First and Third lakes.

Diemyctilus viridescens Rafinesque. In shallow water of Round Pond and Second Lake, especially over *Eriocaulon* and *Lobelia*.

Rana virescens Kalm.

septentrionalis Baird:

clamata Daudin.

catesbiana Shaw.

Bufo lentiginosus americanus Le Conte. Toad.

Reptiles—

Thamnophis sirtalis Linn. Abundant along shores.

Turtles were seen in the First Lake inlet, at too great distance to be specifically determined.

Birds—[a]

6. *Podilymbus podiceps* Linnæus. Pie-billed grebe.

7. *Gavia imber* Gunn. Loon.

51. *Larus argentatus* Brünn. Herring gull.

58. *Larus atricalla* Linnæus. Laughing gull.

74. *Sterna antillarum* Lesson. Least tern.

129. *Merganser americanus* Cassin. Shelldrake.

133. *Anas obscura* Gmelin. Black duck.

190. *Botaurus lentiginosus* Montagu. American bittern.

194. *Ardea herodias* Linnæus. Great blue heron.

201. *Butorides virescens* Linnæus. Little green heron.

230. *Gallinago delicata* Ord. Wilson's snipe.

239. *Actodromas maculata* Viellot. Pectoral sandpiper.

256. *Helodramas solitarius* Wilson. Solitary sandpiper.

258. *Symphemia semipalmata* Gmelin. Willet.

263. *Actitis maculata* Linnæus. Spotted sandpiper.

274. *Aegialitis semipalmata* Bonaparte. Semipalmated plover.

352. *Haliaeetus leucocephalus* Linnæus. Bald eagle.

364. *Pandion haliaëtus carolinensis* Gmelin. American goshawk.

390. *Cerlye alcyon* Linnæus. Belted kingfisher.

Mammals—

Fiber zibethicus Linnæus. Muskrat.

Lutreola vison Schreber. Mink.

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[a] Number and nomenclature of the American Orthnologists' Union Check List, second edition, 1905. List furnished by Mr. Edgar Tweedy, Danbury, Conn.

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TABLE I.—METEOROLOGICAL OBSERVATIONS DURING THE SUMMER OF 1904 AT FIRST LAKE.

Date.	Air.					Sky.	Precipitation.	Surface of the lake water.	
	Temperature.			Wind.					
	Mean.	Maximum.	Minimum.	Direction.	Velocity per hour.			Temperature.	Condition
1904.	°F.				Miles.			°F.	
July 1	70	.....	.....	S. E.	1	Clear	.....	66	Smooth.
2	60.5	.....	.....	W.	1	Cloudy	Rain	.....	Do.
3	53.5	.....	.....	.....	.....	Partly cloudy	.....	.....	
4	65.5	.....	.....	S.	10	do	.....	66	Rough.
5	66.5	.....	.....	S., W., S.	1–3	do	Rain	65	Smooth.
6	63	.....	.....	E.	2	do	do	.....	Do.
7	64	.....	.....	W.	1–2	Clear	.....	66	Do.
8	62.5	.....	.....	W.	1–2	do	.....	67	Do.
9	70.5	.....	.....	S.	10	do	.....	.....	Rough.
10	62.5	.....	.....	S.	6	Cloudy	.....	.....	Waves.
11	65	.....	.....	S.	1–2	Partly cloudy	.....	.....	Smooth.
12	69	.....	.....	S.	9	do	.....	.....	Rough.
13	55	.....	.....	W.	12	do	Rain	66	Do.
14	58.5	.....	.....	S.	4	do	.....	69	Waves.
15	69	.....	.....	W., S. W.	3	do	.....	69	Smooth.
16	67.5	.....	.....	S. W.	1–3	do	.....	69	Do.
17	61	.....	.....	N. W.	2–3	Cloudy	.....	.....	Do.
18	67.5	.....	.....	W.	0–1	Clear	.....	71	Do.
19	75	.....	.....	E.	15	Partly cloudy	.....	72.5	Do.
20	67.5	.....	.....	W.	15	do	.....	73	Rough.
21	62.5	.....	.....	W.	15–5	do	.....	71	Do.
22	56.5	72	43	W.	4	do	.....	69	Waves.
23	58.5	63	49	S. E.	4	Cloudy	.....	69	Do.
24	61.7	70	55	N. E., S. E.	3–4	do	Rain	.....	Rough.
25	64	72	60	E.	2	do	.....	69	Smooth.
26	68	81.5	61	S.	1–6	do	Rain	69	Waves.
27	66	75	63	S., W.	3	Partly cloudy	do	.....	Do.
28	66	86.5	54	S.	3–4	do	do	70	Do.
29	57	71	52	W.	5–20	Cloudy	do	69	Rough.
30	59.5	75	44	W.	1–5	do	.....	.....	Waves.
31	72	80	55	W., S.	4–6	Partly cloudy	Rain	.....	Do.
Aug. 1	67.5	75	64	W.	4–8	Cloudy	.....	69	Do.
2	62.5	78	60	W.	1–2	do	.....	.....	Smooth.
3	62.5	82	54.5	W., S. W.	1–2	Clear	.....	.....	Do.
4	63	82	45	W.	1–2	do	.....	69	Do.
5	66	79	55	S. E., S.	10–25	Partly cloudy	.....	.....	Rough.
6	65	81	62	S. E.	10	do	Rain	.....	Do.
7	57	80	53	W.	20–0	Clear	.....	.....	Do.
8	54	71	46	W.	5–10	Cloudy	Rain	.....	Do.
9	53	71	41	W.	10	Clear	.....	67	Do.
10	68.5	72	41.5	S., S. E.	10–15	Partly cloudy	Rain	.....	Do.
11	59.5	71	57	W.	4–1	Cloudy	do	67	Smooth.
12	59.5	85	54	N., E., S.	4–1	Partly cloudy	.....	69	Do.
13	58.5	65	49	E., S.	3	Cloudy	Rain	.....	Do.
14	60	79	58	S.	0–4–0	do	do	.....	Do.
15	58.5	70	55	W.	0–10–0	Partly cloudy	do	67	Rough.
16	.....	.....	44	.....	.....	.....	do	.....	
17	.....	.....	.....	.....	.....	.....	do	.....	
18	.....	.....	.....	.....	.....	.....	do	.....	
19	51.5	78	41	N. E.	4	Partly cloudy	do	66	Waves.
20	54	63	44	S., S. W.	25–40	Cloudy	do	66	Rough.
21	51	70	49	S.	3	Clear	do	.....	Waves.
22	60.5	82	44	S.	15	Partly cloudy	do	64	Rough.
23	50	68	46	W.	4	Clear	.....	64	Waves.
24	54.5	80	38	W.	6	do	.....	.....	Do.
25	68.5	80	46	S.	10	do	.....	64	Rough.
26	48	61	47	W.	15	do	.....	64	Do.
27	54.5	71	39	W.	10	Partly cloudy	.....	.....	Do.
28	58.5	70	43	W.	6–8	Clear	.....	.....	Waves.
29	50	63	46	W.	15	Partly cloudy	Rain	62	Rough.
30	50	69	34	W.	6	do	.....	.....	Waves.
31	46.5	61	37	W.	3–15–3	do	.....	61	Rough.
Sept. 1	53	71	31	S. E.	1–7–0	do	.....	62	Waves.
2	60.5	69	56	N. E., S.	0–3–0	Cloudy	Rain	63	Smooth.
3	64.5	71	60	S. E.	0–10	do	do	.....	Waves.
4	59	65	54	W.	5	do	do	.....	Do.
5	51	58	47	W.	5	do	do	.....	Do.
6	43	65	35	W.	0–5–0	Clear	.....	63	Smooth.

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TABLE II.—TEMPERATURES[a] OF THE CONNECTICUT LAKES DURING THE SUMMER OF 1904.

Depth.	July 7, First Lake, station C.	July 14, First Lake, station C.	July 15, First Lake, station A.	July 16, First Lake, station B.	July 20, First Lake, station F.	July 21, First Lake, station D.	July 26, First Lake, station E.	August 9, Round Pond.	August 11, First Lake, station D.	August 17, Third Lake.	August 24, Second Lake.	August 29, First Lake, station B.	September 6, First Lake, station B.
Feet.	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
0	67	68	70	69	74	70	70	69	67	66	64	62	62
5	66	68	68	69	.....	70	70	.....	67	66	64	.....	.....
10	65	66	68	69	.....	69	68	.....	67	66	64	.....	.....
15	64	65	68	?62	.....	68	68	.....	67	.....	63	.....	.....
20	63	62	66	65	70	66	64	52	67	65	62	62	62
22.5	58	.....	57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	57	49	54	59	66	60	57	.....	62	.....	59	54	61
27.5	54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	51	48	52	52	49	53	49	45	51	52	55	51	61
40	48	47	49	48	.....	50	.....	[b]44	49	45	50	48	51
50	47	46	48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
60	47	46	46	.....	.....	.....	46	.....	47	.....	[c]50	47	.....
70	.....	46	46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	.....	46	46	46	.....	.....	46	.....	46	.....	.....	46	.....
90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
100	.....	.....	.....	.....	.....	.....	45	.....	46	[d]43	.....	.....	.....
120	.....	.....	.....	.....	.....	.....	.....	.....	46	.....	.....	.....	.....
140	.....	.....	.....	.....	.....	45	.....	.....	45	.....	.....	.....	.....

[a] The temperatures taken July 7 were of samples of water secured by the bottle method. The later temperatures were taken with recording deep-sea trip thermometer.
[b] At a depth of 47 feet.
[c] At a depth of 63 feet.
[d] At a depth of 103 feet.

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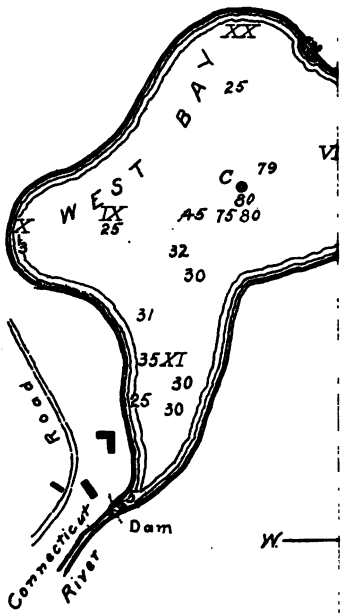

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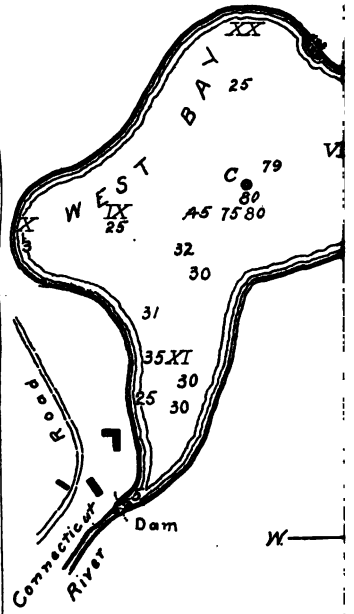

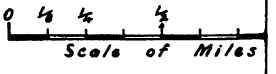

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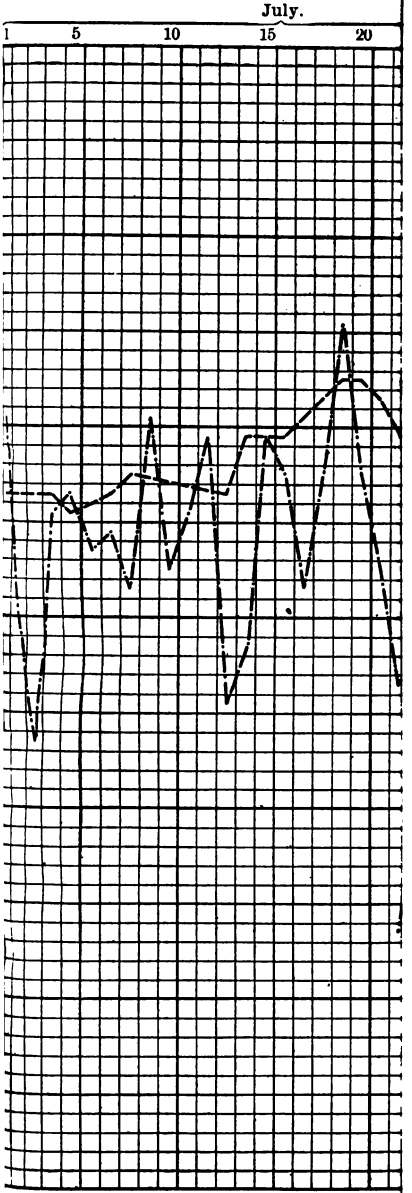

HART EXHIBITING THE RELATION OF THE DAIL
OF

— — — — — — — — Mean temper
— — · — — · — — — Maximum

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